DRUŠTVO GENETIČARA SRBIJE
SEKCIJA ZA OPLEMENJIVANJE ORGANIZAMA

SERBIAN GENETIC SOCIETY
SECTION OF THE BREEDING OF ORGANISMS

DRUŠTVO SELEKCIONERA I SEMENARA
REPUBLIKE SRBIJE

SERBIAN ASSOCIATION OF PLANT
BREEDERS AND SEED PRODUCERS

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X SIMPOZIJUMA DRUŠTVA SELEKCIONERA I SEMENARA
REPUBLIKE SRBIJE
i
VII SIMPOZIJUMA SEKCIJE ZA OPLEMENJIVANJE ORGANIZAMA
DRUŠTVA GENETIČARA SRBIJE

VRNJAČKA BANJA, 16.-18. OKTOBAR 2023.

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X SYMPOSIUM OF THE SERBIAN ASSOCIATION OF PLANT
BREEDERS AND SEED PRODUCERS
AND
VII SYMPOSIUM OF THE SERBIAN GENETIC SOCIETY
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I tematska oblast / Topic I

Genetički resursi

Genetic Resources

I-PP 01

TEHNOLOGIJA POLINATORSKIH TRAKA ZA VEĆI AGROBIODIVERZITET

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Poslednjih godina zabeležen je dramatičan pad pojave i raznovrsnosti svih vrsta divljih insekata oprašivača, uključujući: divlje pčele, osolike muve, leptire i moljce, a brojne vrste oprašivača izumrle su ili im preti izumiranje (COM 2018, 395). Ovo je ozbiljan razlog za zabrinutost jer su oprašivači sastavni deo zdravih ekosistema, a posledice su nesagledive za ekologiju, društvo i ekonomiju. Promene u korišćenju zemljišta, intenzivno upravljanje poljoprivredom, prekomerna upotreba pesticida, zagađenje životne sredine, invazivne vrste, patogeni organizmi i klimatske promene glavne su pretnje oprašivačima. Uvođenje cvetnih polinatorskih traka u plodorede može doprineti stvaranju novih staništa i podstaći povećanje broja i raznolikosti divljih oprašivača na lokalnom nivou, ali i na nivou čitavog predela. Pokazalo se da ova praksa pogoduje i drugim korisnim organizmima: insektima predatorima, parazitoidima, pticama i biljkama, tako da se povećava i broj jedinki i broj vrsta. Navedena tehnologija može poboljšati ukupni biodiverzitet i funkcije ekosistema, uključujući smanjenje populacije štetnih organizama i korova, unapređenje plodnosti zemljišta. Veliki broj inostranih kompanija proizvodi mešavine semena za polinatorske trake, a nihov sastav zavisi od namene i atraktivnosti izabranih biljnih vrsta, poželjnim grupama insekata. Tako u smešama za biološku kontrolu dominiraju vrste iz porodice *Apiaceae*, dok se za ekosistemske usluge oprašivanja koriste mešavine sa vrstama pretežno iz porodice *Fabaceae*. Trenutno na srpskom tržištu ne postoje upakovane mešavine semena za polinatorske trake, a upitna je primenljivost inostranih smeša u plodoredima Srbije, jer se agroekološki, tehničko-tehnološki i socijalni uslovi bitno razlikuju. To otvara veliki prostor za pokretanje istraživačkih programa za modeliranje ove tehnologije za potrebe agroekoloških uslova Srbije.

Ključne reči: polinatri, polinatorske trake, agrobiodiverzitet, ekosistemske usluge

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POLLINATOR STRIP TECHNOLOGY FOR GREATER AGROBIODIVERSITY

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A dramatic decline in the occurrence and diversity of all wild insect pollinator species has been recorded in recent years, including: wild bees, wasps, butterflies and moths, and numerous pollinator species are extinct or threatened with extinction (COM 2018, 395). This is a serious cause for concern because pollinators are an integral part of healthy ecosystems, and the consequences for ecology, society and the economy are incalculable. Changes in land use, intensive agricultural management, excessive use of pesticides, environmental pollution, invasive species, pathogenic organisms and climate change are the main threats to pollinators. The introduction of flower pollinator strips into crop rotations can contribute to the creation of new habitats and encourage an increase in the number and diversity of wild pollinators at both local and landscape level. This practice also favours other beneficial organisms: predatory insects, parasitoids, birds and plants, as both the number of individuals and species increase. This technology can improve soil fertility, overall biodiversity and ecosystem functions, including reducing populations of harmful organisms and weeds. A large number of foreign companies produce seed mixtures for pollinator strips, and their composition depends on the purpose and attractiveness of the selected plant species to the desired groups of insects. Mixtures for biological control are dominated by species from the *Apiaceae* family, while mixtures with species predominantly from the *Fabaceae* family are used for pollination ecosystem services. Currently, there are no packaged seed mixtures for pollinator strips on the Serbian market, and the applicability of foreign mixtures in Serbian crop rotations is questionable, because the agro-ecological, technical-technological and social conditions are significantly different. This opens up a great opportunity for launching research programs for modeling this technology for the needs of agro-ecological conditions in Serbia.

Key words: pollinators, pollinator strips, agrobiodiversity, ecosystem services

Acknowledgement: This work is the result of the project: „EcoStack: Stacking of ecosystem services: mechanisms and interactions for optimal crop protection, pollination enhancement, and productivity (H2020, Grant No. 773554, 2018-2023)",and the research was supported by the Ministry of Education, Science, Technological Development and Innovation of the Republic of Serbia, Grant no. 451-03-68/2022-14 / 200011, 200003.

I-PP-02

KAKO SAČUVATI GENETIČKE RESURSE UGROŽENE VRSTE – PRIMJER PANČIĆEVE OMORIKE

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Shodno IUCN klasifikaciji (*The International Union for Conservation of Nature*) Pančićeva omorika (*Picea omorika* (Pančić) Purkyně) se nalazi u kategoriji svijetski ugroženih vrsta (*Endangered species*). U isto vrijeme oko 99% ugroženih vrsta je u opasnosti da potpuno nestanu zbog ljudskih aktivnosti. Uporedo sa napred nevedenim činjenicama, danas se preduzimaju brojne aktivnosti kako bi se očuvali genetički resursi ove kao i brojnih drugih vrsta. Za Pančićevu omoriku vrijedi da jenajljepši četinar, evolutivno najstarija, a taksonomski najmlađa opisana drvenasta vrsta Evrope. Od momentra njenog otkrića (Pančić, 1875) do danas, njen areal i brojnost se smanjuju. S obrzirom da se od prirode javlja samo u srednjem toku rijeke Drine samo dvije države (Srbija i Bosna i Hercegovina) mogu preduzimati aktivnosti na *in situ* mjerama očuvanja ove vrste. U poslednjih 10 godina intenzivno se provode *in situ* i *ex situ* mjere očuvanja ove vrste. Prva istraživanja dokazuju značajne međupopulacione razlike i zahtjevaju strategiju "jedna populacija – jedna konzervaciona jedinica". Sve populacije su rangirane po stepenu ugroženosti čime su definisani prioriteti u daljim aktivnostima. Uporede sa praćenjem i podrškom prirodnoj obnovi, proizvodnja sadnog materijala se realizuje na nivou linija polusrodnika zbog čega se trenutno intenzivno traže najbolje lokacije za osnivanje *ex situ* zasada. Dosadašnja iskustva i rezultati ukazuju da pasivna zaštita nije najbolja opcija za očuvanje genetičkih resursaPančićeve omorike te da se kombinacijom dvije strategije očuvanja genetičkih resursa (*in situ* i *ex situ*) mogu očekivati bolji rezultati u skorijoj budućnosti.

Ključne reči: *in situ, ex situ* očuvanje, Pančićeva omorika, aktivna zaštita

HOW TO PRESERVE THE GENETIC RESOURCES OF AN ENDANGERED SPECIES – THE EXAMPLE OF SERBIAN SPRUCE

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According to the IUCN classification (*The International Union for Conservation of Nature*), the Serbian spruce (*Picea omorika* (Pančić) Purkyně) is categorized as an endangered species. Unfortunately, about 99 percent of endangered species are at risk of disappearing completely due to human activities. However, various efforts are being made today to preserve the genetic resources of this species and many others. The Serbian spruce is considered the most beautiful conifer, the oldest species in evolutionary terms, and the youngest tree species described taxonomically in Europe. Since its discovery by Pančić in 1875, the range and population of the Serbian spruce have been declining. It is naturally found only in the middle course of the Drina River, limiting conservation efforts to two countries, Serbia and Bosnia and Herzegovina. Over the last decade, both *in situ* (on-site) and *ex situ* (off-site) conservation measures have been extensively implemented for the Serbian spruce. Studies have revealed significant inter-population differences, leading to the strategy of "one population - one unit". Populations are ranked based on their vulnerability levels, which then determine the priorities for future conservation activities. Additionally, efforts are made to support natural regeneration, and the production of seedlings is undertaken half-sib lines. Intensive searches are being carried out to identify the best locations for establishing *ex situ* plantations. The experiences and results obtained so far indicate that passive protection alone is not sufficient to preserve the genetic resources of the Serbian spruce. Instead, combining both *in situ* and *ex situ* conservation strategies seems to offer better prospects for achieving successful preservation in the near future.

Key words: *in situ, ex situ* conservation, Serbian spruce, active protection

I-PP-03

OČUVANJE GENETIČKIH RESURSA KROMPIRA POMOĆU MORFOLOŠKE I GENETIČKE KARAKTERIZACIJE

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Sve intenzivnije klimatske promjene nameću potrebu i za intenzivnijim istraživanjem i evaluacijom genetičkih resursa starih sorti, lokalnih populacija i divljih srodnika gajenih biljaka zbog njihove velike potencijalne važnosti kao izvora gena važnih agronomskih osobina. Ovi resursi imaju ekonomski značaj samo ako se održivo koriste, za što je potrebno da oni budu kvalitetno čuvani, dokumentovani i opisani. Da bi se dobila jasna procjena vrijednosti genofonda krompira Crne Gore obavljena je morfološka i genetička karakterizacija 52 lokalne populacije sakupljene u periodu od 2008-2010. godine. Morfološkim analizama 11 karakteristika klice, uz primjenu UPOV deskriptora, identifikovano je 16 različitih fenotipova. Molekularna procjena genotipova, uz upotrebu 12 mikrosatelitskih (SSR) markera, pokazala je postojanje 13 grupa. Poređenjem DNK materijala crnogorskog genofonda krompira sa bazom od preko 3000 genotipova, odnosno 8000 sorti koja se nalazi na SASA institutu u Škotskoj utvrđeno je postojanje 5 unikatnih genotipova od kojih su dva bila duplikati. Ovi rezultati mogu značajno doprinijeti njihovoj boljoj promociji, ex situ i in situ očuvanju, kao i vraćanju biodiverziteta na poljoprivredne površine.

Ključne riječi: krompir, genetički resursi, lokalne populacije, karakterizacija

CONSERVATION OF POTATO GENETIC RESOURCES USING MORPHOLOGICAL AND GENETIC CHARACTERIZATION

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Increasingly intense climate changes impose necessity for more thorough research and evaluation of genetic resources of old varieties, local populations and wild relatives of cultivated plants due to their great potential as a source of genes for significant agronomic traits. These resources have economic significance only if used sustainably, which requires adequate conservation, documentation and description. Aiming to obtain a clear assessment of the value of potato gene pool in Montenegro, morphological and genetic characterization of 52 local populations collected in the period from 2008-2010 was carried out. Morphological analyses of 11 sprout characteristics using UPOV descriptors identified 16 different phenotypes. Molecular assessment of genotypes, applying 12 microsatellite (SSR) markers, showed the existence of 13 groups. By comparing the DNA material of potato gene pool from Montenegro with a database of over 3000 genotypes, i.e. 8000 varieties located at the SASA Institute in Scotland, the existence of five unique genotypes was confirmed, with two duplicate genotypes. These results can significantly contribute to better promotion, ex situ and in situ conservation, as well as the reintroduction of biodiversity to agricultural areas.

Key words: potato, genetic resources, local populations, characterisations

I-PP-04

MOLEKULARNA RAZNOLIKOST DIVLJIH I KULTIVIRANIH BRASSICA OBALNOG PODRUČJA ISTOČNOG JADRANA

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Porodica Brassicaceae jedna je od najvećih familija iz grupe dikotiledona, među kojima je rod *Brassica* jedan od najvažnijih budući da uključuje mnoge divlje srodnike i odomaćene vrste koje se uzgajaju kao povrtarske i industrijske kulture širom sveta. Istočni Jadran dobro je poznat kao područje s visokim nivoom biološke raznolikosti divljih i kultivisanih kupusnjača. Endemske vrste *B. botterii* Vis., *B. cazzae* Ginzb. & Teyb. i *B. mollis* Vis. su ranije prepoznate na južnim hrvatskim ostrvima, no postoji sumnja da li se radil o sinonimima ili su na nivou podvrste *B. incana*. Taksonomski položaj ovih vrsta unutar kompleksa *B. incana* nije poznat; stoga je biljni materijal prikupljen i analiziran pomoću molekularnih alata. Osim prisutnosti divljih srodnika *Brassica*, uz obalu i ostrva istočnog Jadrana tradicionalno se uzgaja i raštan (*Brassica oleracea* var. *acephala*). U projektu je prikupljeno 25 populacija raštana s tog područja i analizirana je genetska raznolikost unutar i između populacija korišćenjem SSR markera. Dendrogram koji spaja najbliže susede (neighbour-joining tree) podelio je prikupljene divlje srodnike vrste *Brassica* u dve glavne skupine: klasu Apeninsko-sicilijansko-jadransku, koja odgovara tipičnoj *B. incana*, i klasu srednjeg Jadrana, koja odgovara klasi *B. botteri*. Što se tiče kelja, analiza je izdvojila glavne klastere prema geografskom poreklu, s prisutnošću šest mešanih populacija, koje su uglavnom bile prisutne na ostrvima severnog Jadrana i u Dalmatinskoj zagori. Potvrdili smo da je istočni Jadran važno područje s obzirom na molekularnu raznolikost kupusnjača, a prikupljene populacije mogu biti vredan genski fond za dalje programe oplemenjivanja.

Ključne reči: AFLP, filogenetika,kupus, SSR, taksonomija

Zahvalnica: Ovo istraživanje je podržano projektom KK.01.1.1.01.0005 "Bioraznolikost i molekularno oplemenjivanje biljaka

MOLECULAR DIVERSITY OF WILD AND CULTIVATED BRASSICA ALONG EASTERN ADRIATIC COSTAL AREA

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The Brassicaceae family is one of the largest families of the dicotyl group, among which the genus *Brassica* is one of the most important since it includes many crops wild relatives and domesticated species, grown as and vegetable and industrial crops worldwide. Eastern Adriatic is well recognized as an area with high level of biodiversity of wild and cultivated *Brassica's*. Endemic species *B. botterii* Vis., *B. cazzae* Ginzb. & Teyb., and *B. mollis* Vis. have been recognized previously on southern Croatian islands, however, there is a doubt are they synonyms or at the subspecific level of *B. incana*. The taxonomic position of these species within the *B. incana* complex is not known; therefore plant material was collected and analyzed using molecular tools. Besides the *Brassica* wild relatives presence, leafy kale (*Brassica oleracea* var. *acephala*) is traditionally grown alongside of Eastern Adriatic coast and islands. We have collected 25 kale accessions from the area and analyzed genetic diversity within and between populations by using SSR markers. The neighbour-joining tree divided the collected Brassica wild relatives in two main groups: the Apennine-Sicilian-Adriatic clade, corresponding to the typical *B. incana*, and the central Adriatic clade, corresponding to the *B. botteri* clade. Regarding kale, analysis distinguished tree main clusters according to geographical origin, with presence of six admixed populations, which were mostly present in Northern Adriatic islands and Dalmatian hinterland region. We have confirmed Eastern Adriatic as an important area regarding *Brassica* molecular diversity and collected populations may be a valuable gene pool for further breeding programs.

Key words: AFLP, cabbage, phylogenetic, taxonomy, SSR

Acknowledgement: This research has been supported by the project KK.01.1.1.01.0005 "Biodiversity and Molecular Plant Breeding"

I-PP-05

ZNAČAJ DIVLJIH SRODNIKA RATARSKIH BILJAKA I DIVLJIH BILJAKA ZA ISHRANU I OPLEMENJIVANJE

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Divlji srodnici ratarskih biljaka i divlje biljke pogodne za direktnu ishranu su značajan izvor raznovrsnosti za oplemenjivanje novih sorti. Zbog rasta u prirodnim uslovima spoljašnje sredine, dobro su prilagođeni promenljivim uslovima gajenja određenog područja. Ekstremni ekološki pritisci i nepromišljene ljudske aktivnosti u prirodnim staništima i nekontrolisana eksploatacija smanjuju njihovu raznovrsnost i obilje. Ovi genetski resursi obuhvataju divlje srodnike mnogih ekonomski važnih ratarskih biljaka, korisnih za ishranu, stočnu hranu, medicinske i industrijske svrhe itd. Sadrže mnoge važne osobine koje nisu prisutne u gajenim vrstama, pa predstavljaju važnu germplazmu za oplemenjivanje i smatraju se neotkrivenim delom ratarskog biodiverziteta u mnogim evropskim zemljama. Njihovo očuvanje je u Evropi zanemareno zbog nedovoljne svesti i znanja o njihovom značaju, i zbog nedovoljnih organizacionih i finansijskih ulaganja. Samo nekoliko zemalja ili regiona u Evropi (Nordijske zemlje, Češka) ima razvijene strategije za njihovo očuvanje. U Nemačkoj su počeli da se osnivaju genetski rezervati divljeg celera, vinove loze i trava. Jedan od prioritetnih zadataka kako ECPGR tako i Evropske strategije za biljne genetičke resurse (2021), je unapređenje *in situ* očuvanja i održivog korišćenja divljih srodnika ratarskih biljaka i divljih biljaka za ishranu. Za postizanje ovog cilja potrebno je izraditi: i) nacionalne liste, ii) liste prioriteta ekotipova i iii) nacionalne strategije za očuvanje i upravljanje *in situ* u prirodnim sredinama. Takođe, za najugroženije vrste kojima preti genetska erozija, potrebno je omogućiti bezbednosno čuvanje u *ex situ* uslovima.

Ključne reči: genetski resursi, divlji srodnici ratarskih biljaka, divlje biljke za ishranu, oplemenjivanje

IMPORTANCE OF CROP WILD RELATIVES AND WILD FOOD PLANTS FOR NUTRITION AND BREEDING

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Crop wild relatives and wild food plants suitable for direct consumption are an indispensable source of diversity for breeding new varieties. Because of the constant environmental influences, they are well adapted to the changing growing conditions of a particular area. Extreme ecological pressure and reckless human activity in natural habitats, as well as uncontrolled exploitation, are reducing their diversity and abundance. These genetic resources include wild relatives of many economically important agricultural plants, useful for food, feed, medicinal and industrial purposes, etc. They contain many important traits not present in cultivated species, so they represent an important germplasm source for breeding and an undiscovered part of agricultural biodiversity in many European countries. Their preservation is neglected in Europe because there is insufficient awareness and knowledge of their importance, as well as organizational and financial investments. Few countries or regions in Europe (Nordic countries, Czech Republic) have developed strategies for their conservation, and in Germany, genetic reserves of wild celery, vines, and grasses have begun to be established. One of the priority tasks of both the ECPGR and the European Strategy for Plant Genetic Resources (2021) is to improve the *in situ* conservation and sustainable use of crop wild relatives and wild food plants. To achieve this goal, there is a need to establish: (i) national lists, (ii) priority lists of ecotypes, and (iii) national strategies for *in situ* conservation and management in natural environments and, for the most endangered species at risk of genetic erosion, also safe *ex situ* feeding.

Key words: genetic resources, crop wild relatives, wild food plants, breeding

I-POS-06

PROCENA GENETIČKOG DIVERZITETA GERMPLAZME PLAVOG PATLIDŽANA KORIŠĆENJEM RAPD MARKERA

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Evaluacija genetičkih resursa plavog patlidžana (*Solanum melongena* L.) sa različitih geografskih područja primenom molekularnih markera (RAPD) je od velikog značaja u procesu oplemenjivanja. Ukupno 90 polimorfnih amplifikovanih proizvoda dobijeno je od 10 dekamernih RAPD prajmera, korišćenih za analizu genetičkog diverziteta 20 genotipova plavog patlidžana (16 lokalnih i 4 genotipova stranog porekla). Najviši polimorfizam je konstatovan prilikom korišćenja OPAF-16 prajmera (70,83%). Broj detektovanih amplifikovanih fragmenata je bio od 13 (OPF-04) do 24 (OPAF-16), dok je prosečan broj fragmenata po prajmeru iznosio 17,2. Dužine amplifikovanih fragmenata su bile u rasponu od 400 do 9000 bp. Vrednost *Jaccard*-ovog koeficijenta genetičke distance bila je od 0,095 do 0,35, a dendrogram konstruisan metodom UPGMA pokazao da se 16 lokalnih i 4 stranih genotipova grupisalo se u devet grupa (klastera). Populacije K1, K8/1, K19, K22, K25 i K38 predstavljaju genotipove koji su se odvojile od ostalih i formirali su pojedinačne klastere. Najniža vrednost izračunate genetičke distance iznosila je 0,095 između domaćih genotipova K13 i K12, koji su i sa morfološke strane pokazali sličnost u pogledu oblika i boje. S druge strane, najveća vrednost genetičke distance izračunata je između stranih genotipova K19 i K25(0,35), K19 i K34 (0,34) i K19 i K38 (0,34). Genetski različiti genotipovi identifikovani korišćenjem RAPD markera mogu biti potencijalni početni genetički materijal za ukrštanje sa drugim genotipovima radi dobijanja novih i poboljšanih sorti patlidžana.

Ključne reči: *Solanum melongena* L., genetički resursi, diverzitet, RAPD markeri

Zahvalnica: Rad je realizovan uz podršku Ministarstva za nauku, tehnološki razvoj i inovacije Republike Srbije (br. 451-03-47/2023-01/200216; 451-03-47/2023-01/200054)

ASSESSMENT OF EGGPLANT GERMPLASM GENETIC DIVERSITY USING RAPD MARKERS

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Evaluation of genetic resources of eggplant (*Solanum melongena* L.) from different geographical areas using molecular markers (RAPD) is of great importance in the breeding process. A total of 90 polymorphic amplified products were obtained from 10 decameric RAPD primers, used to analyze the genetic diversity of 20 genotypes of eggplant (16 local and 4 genotypes of foreign origin). The highest polymorphism was determined using the OPAF-16 primer (70.83%). The number of detected bands ranged from 13 (OPF-04) to 24 (OPAF-16), while the average number of bands per primer was 17.2. The lengths of the amplified fragments ranged from 400 to 9000 bp. The value of the Jaccard's genetic distance coefficient ranged from 0.095 to 0.35, and the dendrogram constructed using the UPGMA method showed that 16 local and 4 foreign genotypes were grouped into nine groups (clusters). Populations K1, K8/1, K19, K22, K25 and K38 represent genotypes that separated from the others and formed single clusters. The lowest value of the calculated genetic distance was 0.095 between domestic genotypes K13 and K12, which also showed morphological similarity in terms of shape and color. On the other hand, the highest value of genetic distance was calculated between foreign genotypes K19 and K25 (0.35), K19 and K34 (0.34) and K19 and K38 (0.34). Genetically distinct genotypes identified using RAPD markers could be potential starting genetic material for crossing with other genotypes to obtain new and improved eggplant varieties.

Key words: *Solanum melongena* L., genetic resources, diversity, RAPD markers

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I-POS-07

MORFOLOŠKE KARAKTERISTIKE SEMENA TISE (*TAXUS BACCATA* L.) SA PARKOVSKIH STABALA

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Taxus baccata L. je retka vrsta u šumama Srbije i uživa status zaštićene vrste kao tercijarni relikt. Nasuprot njenom prirodnom staništu, u parkovima je zastupljena vrsta. Tisa je dvodoma vrsta koja plodonosi svake ili svake druge godine, a seme je okruženo mesnatim crvenim omotačem koji je izuzetno atraktivnog izgleda. Podaci o morfološkim karakteristikama semena tise su ograničeni na mali broj literaturnih izvora usled retkog sakupljanja semena i značajno češćeg razmnožavanja vegetativnim putem. Sa ciljem da se istraži varijabilnost morfoloških karakteristika semena i diverzitet semena tise u urbanim sredinama, izvršeno je sakupljanje semena tokom jeseni 2021. godine sa ukupno 13 stabala tise (11 stabala iz Beograda i po jedno iz Novog Sada i Vrdnika). Morfološke karakteristike semena (dužina i širina semena i prečnik ožiljka na semenu) sa ovih stabala nalaze se u granicama vrednosti koje su prijavljene u literaturi za seme tise. Značajna varijabilnost u karakteristikama semena između posmatranih stabala je dokazana primenom jednofaktorijalne analize varijanse, a potom je izvršeno grupisanje primenom post-hoc Tukey HSD testa. Pojedina stabla koja se prostorno nalaze blizu jedno drugom, pokazala su veći stepen sličnosti semena u odnosu na prostorno udaljena stabla, što je ispitano primenom klaster analize (Tree Clustering, Single Linkage-Euclidean distances).

Ključne reči: tisa, *Taxus baccata*, seme, morfološke karakteristike

MORPHOLOGICAL CHARACTERISTICS OF YEW (*TAXUS BACCATA* L.) SEEDS FROM URBAN TREES

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Taxus baccata L. is a rare species in the forests of Serbia and enjoys the status of a protected species as a tertiary relic. In contrast to its natural habitat, this species is widespread in the parks. Yew is a dioecious species that bears fruit every year or every other year, and the seeds are surrounded by a fleshy red covering that is extremely attractive. Data on the morphological characteristics of yew seeds are limited to a small number of literature sources due to the infrequent collection of seeds and significantly more frequent vegetative reproduction. Aiming to investigate the variability of morphological characteristics of seeds and the diversity of yew seeds in urban areas, seed collection was carried out during the fall of 2021 from a total of 13 yew trees (11 trees from Belgrade and one each from Novi Sad and Vrdnik). Morphological characteristics of seeds (length and width of seeds and diameter of seed scar) from these trees are within the range of values reported in the literature for yew seeds. Significant variability in seed characteristics between the observed trees was proven using one-factor analysis of variance, and then grouping was performed using the post-hoc Tukey HSD test. Individual trees that are spatially close to each other showed a higher degree of seed similarity compared to spatially distant trees, which was examined using cluster analysis (Tree Clustering, Single Linkage-Euclidean distances).

Key words: yew, *Taxus baccata*, seed, morphological characteristics

I-POS-08

GENETIČKI RESURSI STRNIH ŽITA ON-FARM U SRBIJI 2020-2021 - SAKUPLJANJE, KONZERVACIJA I KORIŠĆENJE

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Ovaj rad predstavlja rezultate sakupljanja lokalnih genetičkih resursa strnih žita u Srbiji u periodu 2020-2021, koje je imalo za cilj dobijanje informacija o trenutnom stanju očuvanja, upravljanja i korišćenja starih sorti i populacija pšenice, ječma, ovsa i raži. Tokom dve godine, prikupljeno je ukupno 12 uzoraka - akcesija, od kojih su sedam bili ječmovi, dva ovsa, dve raži i jedna pšenice iz četiri regiona Srbije. Gajenje i čuvanje lokalnih populacija i starih sorti strnih žita pretežno je zabeleženo u udaljenim planinskim predelima južnih i jugozapadnih delova Zlatiborskog okruga. Najviše uzoraka prikupljeno je sa planinskih visoravni Peštera, gde lokalni poljoprivredni proizvođači još uvek gaje nekoliko lokalnih populacija i starih sorti na malim površinama za ličnu upotrebu, poput populacija ječma buškat, grbavac i pivac. Ove lokalne sorte suvisoko cenjene od proizvođača zbog svojih osobenosti, kao što su otpornost na polegavanje i/ili bolesti, hranljivih vrednosti za ljudsku i stočnu ishranu. Ovi usevi se gaje ili kao pojedinačni usevi ili u mešavini, npr. ječam i pšenica (tzv. polovica), na manje plodnim zemljištima sa minimalnim ulaganjima, što se ogleda u nižim prinosima. Sačuvani su tradicionalni recepti u kojima se koriste lokalne žitarice. Prikupljeni uzorci su opisani, umnoženi, uključeni u poljski ogled i poslati na dugoročno čuvanje u nacionalnu banku gena Republike Srbije i svetski trezor semana na Svalbardu. Svi prikupljeni uzorci su umnoženi radi morfološke karakterizacije. Takođe, ovi genetički resursi su podeljeni drugim proizvođačima i lokalnim bankama semena kako bi ocenili podobnosts tarihsorti i populacija u različitim agroekološkim uslovima, i podstakli razmenu i čuvanje semena među poljoprivrednicima. Prikupljeni genetički resursi imaju značajnu vrednost za aktivnosti predoplemenjivanja i proučavanja genetičke raznovrsnosti.

Ključne reči: banka gena, ječam, kolekcija, ovas, raž

Zahvalnica: Ovo istraživanje je finansirano preko projekta Benefit-Sharing Fund of the International Treaty on Plant Genetic Resources for Food and Agriculture, PR-166-Serbia project: "Redesigning the exploitation of small grains genetic resources towards increased sustainability of grain-value chain and improved farmers' livelihoods in Serbia and Bulgaria-GRAINEFIT".

SMALL GRAINS GENETIC RESOURCES ON FARMS IN SERBIA IN 2020-2021 - COLLECTION, CONSERVATION AND UTILIZATION

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This study presents the outcomes of a two-year collection mission conducted in Serbia during the period of 2020-2021. The mission aimed to gather genetic resources of small grains and obtain information regarding their conservation, management, and utilization. A total of 12 samples were collected, comprising seven accessions of barley landraces, two of oats, two of rye, and one variety of wheat from four regions in Serbia. The preservation of local traditional cereals was predominantly observed in remote and mountainous areas of the southern and southwestern parts of the Zlatibor district. Most samples were collected from the Pester mountain plateaus, where local farmers still cultivate a few traditional varieties on small plots for personal use. These local varieties are highly esteemed by farmers due to various attributes, such as resistance to lodging and diseases, nutritional value for both human consumption and animal feed. The cultivation of these crops occurs either as sole crops or in crop mixtures, on less fertile soils with minimal inputs, resulting in modest yields. Traditional recipes using local cereals have been preserved. The collected accessions were described and stored for the long term in the Serbian National Gene Bank and the Svalbard Global Seed Vault. All collected samples were multiplied for morphological characterization through field trials and distributed to farmers for on-farm evaluations. There have been recent initiatives to establish local community seed banks and encourage seed exchange among farmers. The gathered genetic resources hold significant value for pre-breeding activities and genetic diversity studies.

Key words: barley, collection, oats, rye, genebank

Acknowledgement: This research was funded by the Benefit-Sharing Fund of the International Treaty on Plant Genetic Resources for Food and Agriculture, PR-166-Serbia project: "Redesigning the exploitation of small grains genetic resources towards increased sustainability of grain-value chain and improved farmers' livelihoods in Serbia and Bulgaria-GRAINEFIT".

I-POS-09

OCENA LOKALNIH GENETIČKIH RESURSA PŠENICE NA PRINOS, RANOST I EFIKASNOST REMOBILIZACIJE HRANLJIVIH MATERIJA POMOĆU SENZORA HLOROFILA I VEGETATIVNOG INDEKSA

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Biljni genetički resursi sadrže za oplemenjivače korisne, ali često dovoljno neispitane osobine koje imaju potencijal da poboljšaju otpornost useva u uslovima fluktuirajućih klimatskih promena. Lokalne populacije i stare domaće sorte pšenice poseduju sposobnost adaptacije na lokalne agroekološke uslove, ali ih obično karakteriše kasnostasnost i relativno niski prinosi. S obzirom na značaj ovih osobina i za oplemenjivače i proizvođače, cilj ovog istraživanja bio je da se ispitaju lokalni genetički resursi pšenice iz kolekcije Instituta za ratarstvo i portarstvo, Novi Sad, i utvrde genotipovi sa većim potencijalomza prinos, ranostasnost i efikasnost remobilizacije hranljivih materija. Eksperimentalni ogled sa potpuno slučajnim blok dizajnom u tri ponavljanja postavljen je na Rimskim šančevima tokom dve vegetacione sezone 2020/21 i 2021/2022. Pored toga, ispitivano je postojanje korelacije između ovih osobina i vegetacionog indeksa, površine lista zastavičara i sadržaja hlorofila. Prinos, efikasnost remobilizacije suve materije i doprinos remobilizaciji suve materije su bili u pozitivnoj korelaciji sa normalizovanom diferencijalnim vegetacionim indeksom, površinom zastavičara i sadržajem hlorofila, dok je vreme cvetanja bilo u negativnoj korelaciji sa svim ostalim osobinama. Od ukupno 30 ispitanih genotipova, jedna lokalna populacija i tri sorte su se izdvojile po ranostasnosti, relativno visokom prinosu i srednjoj do visokoj vredosti efikanosti i doprinosa remobilizaciji hranljivih materija. Rezultati sugerišu da ovi genotipovi predstavljaju interesantan potencijalni materijal koji bi se mogao uključiti u oplemenjivačke programe uz dodatna istraživanja.

Ključne reči: evaluacija, NDVI, populacije, pšenica, *Triticum aestivum* L.

Zahvalnica: Ovo istraživanje je finansirano preko projekta Benefit-Sharing Fund of the International Treaty on Plant Genetic Resources for Food and Agriculture, PR-166-Serbia project: "Redesigning the exploitation of small grains genetic resources towards increased sustainability of grain-value chain and improved farmers' livelihoods in Serbia and Bulgaria-GRAINEFIT".

SCREENING LOCAL SERBIAN WHEAT GENETIC RESOURCES FOR YIELD POTENTIAL, EARLINESS AND NUTRIENT REMOBILIZATION EFFICIENCY USING CHLOROPHYLL AND VEGETATIVE INDEX SENSORS

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Plant genetic resources harbor for breeders valuable yet often unexplored traits that have the potential to enhance crop resilience in the face of fluctuating climates. Old local varieties and landraces possess adaptations to local environments, but are typically characterized by late maturity and relatively low yields. Since earliness and high yields are highly valued both by breeders and farmers, this study aimed to screen traditional Serbian landraces and varieties for the high yield potential, early maturing, and better nutrient remobilization efficiency. An experimental trial with the randomized complete block design inthree replications was conducted at the Rimski šančevi, Serbia during 2020/21 and 2021/2022. In addition, the correlation between these traits and vegetation index, flag leaf area, and chlorophyll content were tested. Yield, dry matter remobilization efficiency, and dry matter remobilization contribution exhibited positive correlations with normalized difference vegetation index, flag leaf area, and chlorophyll content, while flowering time showed negative correlations with all other traits. Nevertheless, one landrace and three traditional varieties out of 30 evaluated germplasm displayed early flowering, high yield, and medium to high nutrient remobilization traits. Our results suggest that these genotypes represent interesting potential breeding materials warranting further investigation.

Key words: evaluation, landraces, NDVI, *Triticum aestivum* L., wheat

Acknowledgement: This research was funded by the Benefit-Sharing Fund of the International Treaty on Plant Genetic Resources for Food and Agriculture, PR-166-Serbia project: "Redesigning the exploitation of small grains genetic resources towards increased sustainability of grain-value chain and improved farmers' livelihoods in Serbia and Bulgaria-GRAINEFIT".

I-POS-10

FENOLOŠKO-POMOLOŠKE KARAKTERISTIKE EX-SITU KOLEKCIJE BADEMA NAKON DRUGE GODINE ISTRAŽIVANJA

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Najznačajnije fenološke (početak i kraj cvetanja) i pomološke (morfometrijske karakteristike ploda i jezgre) osobine okalemljenih i zdravih stabala sorti i genotipova badema proučavane su u dvogodišnjem periodu (2020 i 2021. godina) u *ex situ* kolekciji u blizini sela Jazak (Fruška gora)na nadmorskoj visini od oko 350m. Kolekcioni zasad se sastoji od objedinjenog biljnog materijala (36 genotipova) iz kolekcionih zasada Poljoprivrednog fakulteta u Beogradu i Poljoprivrednog fakulteta u Novom Sadu, kao i od materijala preuzetog od privatnih rasadnika i materijala izdvojenog *on farm* selekcijom iz veštačkih populacija. Tokom druge godine proučavanja praćena je fenofaza cvetanja za sve genotipove, dok je pomološka karakterizacija izvršena na genotipovima koji nisu pretrpeli oštećenja uzrokovana kasnim mrazevima. Praćenje fenofaze cvetanja je obuhvatilo momenat od početka cvetanja do početka faze precvetavanja. Pomološka karakterizacija podrazumevala je morfološka merenja ploda i jezgre. Najraniji početak cvetanja evidentiran je kod sorte Buda tetnyi dok su najkasnije u fazu cvetanja ušle sorte Masbovera i Francoli. Najveća masa ploda izmerena je kod sorti Texas (24,09 g) i Ferragnes SU 2 (21,29 g), dok je najveća masa ploda bez klapine izmerena kod sorti Ruski badem (6,38 g) i Supernova (6,10 g). Sorte Masbovera i Texas su se istakle sa najvećom masom jezgre (1,56 g i 1,42 g), Markona sa najvećom širinom (14,73 mm) i debljinom (8,88 mm) jezgre, dok je najveća visina jezgre izmerena kod sorti Gloriete (27,32 mm) i Ferragnes SU 2 (26,22 mm). Dobijeni rezultati ukazuju na to da je fruškogorski region pogodan za gajenje kasnocvetnih genotipova badema.

Ključne reči:*Prunus amygdalus*, *ex situ*, fenološko-pomološka karakterizacija, selekcija

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PHENO-POMOLOGICAL CHARACTERISTICS OF THE *ex situ* ALMOND COLLECTION AFTER THE SECOND YEAR OF STUDY

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The most important phenological (beginning and end of floweing) and pomological (morphometric properties of fruit and karnel) characteristics of grafted and healthy almond cultivars and genotypes grown in an *ex situ* collection near the village of Jazak (Fruška Gora mountain) at an altitude of about 350m were investigated during a two-year period (2020 and 2021). The studied plant material included 36 genotypes that were obtained from the collection plantations of the Faculty of Agriculture in Belgrade and the Faculty of Agriculture in Novi Sad, private nurseries, and *on farm* selected material from an artificial population. Measurements conducted during the second year of the study included monitoring of the flowering phenophase in all genotypes, and pomological characterization of genotypes that were not affected by late frosts. Flowering phase was monitored from the flowering onset to the beginning of the post-flowering phase. Pomological characterization included morphological measurements of the fruit and kernel. The earliest beginning of flowering was recorded in the variety Buda tetnyi, while the varieties Masbovera and Francoli were the latest to enter the flowering phase. The highest fruit weight was measured in the cultivars'Texas' (24.09 g) and 'Ferragnes SU 2' (21.29 g), while the highest fruit weight without flap was measured in the cultivars'Ruski badem' (6.38 g) and 'Supernova' (6.10 g). The cultivars'Masbovera' and 'Texas' had the highest kernel mass (1.56 g and 1.42 g), 'Markona' had the highest width (14.73 mm) and thickness (8.88 mm) of karnel, while the highest kernel height was measured in the cultivars'Gloriete' (27.32 mm) and 'Ferragnes SU 2' (26.22 mm). The obtained results show that the Fruška Gora region is suitable for the cultivation of late-flowering almond genotypes.

Key words: *Prunus amygdalus*, *ex situ*, pheno-pomological characterization, selection

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I-POS-11

MORFOLOŠKI DIVERZITET RODA ORHIS ZASTUPLJENOG NA PODRUČJU FRUŠKE GORE

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Fruška gora predstavlja prirodno stanište velikog broja terestričnih orhideja. Međutim, diverzitet koji stoji na raspolaganju nikada nije bio predmet oplemenjivačkog ciklusa koji bi zastupljene vrste uveo u masovniju upotrebu. Cilj rada bio je da se izvrši osnovna morfološka karakterizacija vrsta terestričnih orhideja koje pripadaju rodu Orchis (*Orchis militaris* i *Orchis purpurea*). Morfološka karakterizacija je obuhvatila merenje kvantitativnih osobina. Kako bi merenja mogla obuhvatiti vegetativne i generativne organe, za svaku biljnu vrstu je uziman biljni materijal tokom cvetanja – maj i jun mesec. Merenje morfometrijskih parametara obuhvatilo je dve populacije vrste *O. militaris* i tri populacije vrste *O. purpurea*. U zavisnosti od veličine populacije, određena je veličina uzorka za merenje, pa je tako kod vrste *O. militaris* uzorak brojao po 10 jedinki iz svake populacije, dok je morfološka karakterizacija vrste *O. purpurea* zbog izuzetno male veličine populacije obuhvatila od 1 do 5 jedinki. Kvantitativni parametri vegetativnih i generativnih organa ukazuju da se vrste znatno razlikuju prema svim osobinama. Dobijeni rezultati ukazuju da su najveće vrednosti morfoloških parametara izmerene kod vrste *O. purpurea*, na lokalitetima 1 i 3 od kojih se najviše ističu visina (434,50 mm), dužina cvasti (106 mm), broj cvetova (40), visina cveta (16,70 mm), širina cveta (12,97 mm), dok su najniže vrednosti zabeležene kod vrste *O. militaris* zastupljene na lokalitetu 1 kod kojih je izmerena prosečna visina habitusa (312 mm), dužina cvasti (75 mm), broj cvetova (30), visina cveta (10,50 mm), širina cveta (5,09 mm). Prikazani rezultati ukzuju da ispitivani genofond ima dobru osnovu za selekciju ornamentalnih karakteristika jedinstvene komercijalne vrednosti.

Ključne reči: diverzitet, oplemenjivanje, terestične orhideje, morfološka karakterizacija

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MORPHOLOGICAL DIVERSITY OF THE GENUS ORCHIS ON THE FRUŠKA GORA MOUNTAIN

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Fruška gora is the natural habitat of many terrestrial orchid species. However, the existing diversity has never been the subject of a breeding cycle that would bring the represented species to wider use. The aim of this study was to perform the basic morphological characterization of the species of terrestrial orchids of the genus *Orchis* (*Orchis militaris* and *Orchis purpurea*). The morphological characterization was based on the measurement of quantitative characteristics of two populations of the species *O. militaris* and three populations of the species *O. purpurea*. The size of the sample depended on the size of the population - 10 individuals were collected from each population of *O. militaris* and 1 to 5 individuals from each population of the species *O. purpurea*, because the extremely small population size. The quantitative parameters of vegetative and generative organs show that the species differ significantly in all characteristics. The highest values of morphological parameters were measured in the species *O. purpurea*, of which the height (434.50 mm), inflorescence length (106 mm), number of flowers (40), flower height (16.70 mm) and flower width (12.97 mm) were the most pronounced. The lowest morphological values were found in the species *O. militaris*. These included average height (312 mm), inflorescence length (75 mm), number of flowers (30), flower height (10.50 mm), and flower width (5.09 mm). The results presented show that the gene pool studied provides a good basis for the selection of ornamental traits with unique commercial value.

Key words: diversity, breeding, terrestrial orchids, morphological characterization

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I-POS-12

PROCENA VARIJABILNOSTI SEMENA DIVLJE KRUŠKE (*Pyrus pyraster* (L.) Burgsd.) PRIMENOM GEOMETRIJSKE MORFOMETRIJE

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Metoda geometrijske morfometrije je inovativna u oblasti šumarstva i kao takva do sada nije bila primenjivana na analizu oblika semena drvenstih vrsta. U radu su prikazani rezultati istraživanja oblika semena poreklom sa 12 test stabala koja su deo genofonda divlje kruške na području PIO „Kosmaj". Cilj istraživanja bio je da se utvrdi da li primena metode geometrijske morfometrije na morfotip semena divlje kruške obuhvata dovoljno visok stepen varijabilnosti semena test stabala i da li kao takva daje pouzdane rezultate o proceni varijabilnosti polaznih populacija. Sa svakog stabla izdvojeno je po 30 semenki i skenirano. Svakoj semenki dodeljene su 4 specifične tačke. Nakon označavanja specifičnih tačaka oblik semena je analiziran primenom analize varijanse, analize glavnih komponenata i kanonijske diskriminantne analize. Analizom varijanse utvrđeno je da postoje statistički značajne razlike u obliku i veličini semena (veličina centroida: $F = 48,86$, $p < 0,0001$; oblik: $F = 2,45$, $p < 0,0001$). Analiza glavnih komponenti opisala je kumulativno 69,87 % varijabilnosti (PC1=44,05%, PC2=25,81%). Kanonijska diskriminantna anliza je opisala 92,50% ukupne varijabilnosti semena (CV1=72,40%, CV2=20,10%). Iako postoje statistički značajne razlike između test stabala, dominantnost posebnog morfotipa nije jasno utvrđena. Ovakav rezultat može biti posledica malog uzorka, kao i nedovoljnog broja digitalizovanih specifičnih tačaka, što predstavlja izazov za buduća istraživanja. Bez obzira na to, dobijeni rezultati ukazuju na visok procenat opisane varijabilnosti semena, kao i postojanje statistički začajnih razlika između test stabala u pogledu morfotipa semena. Sve ovo ukazuje na pouzdanost primene geometrijske morfometrije u cilju procenu varijabilnosti semena drvenastih vrsta.

Ključne reči: morfotip, specifične tačke, test stabala

VARIABILITY ASSESSMENT OF WILD PEAR (*Pyrus pyraster* (L.) Burgsd.) SEEDS USING GEOMETRIC MORPHOMETRY

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The method of geometric morphometry is innovative in the field of forestry and still hasn't been applied to seeds morphotype analysis of woody species. This paper presents the results of research on the seeds shape originating from 12 test trees, as a part of the wild pear gene pool on ONL "Kosmaj". The goal of the research was to determine whether the application of the geometric morphometry method to the morphotype of wild pear seeds includes a sufficiently degree of variability and whether, as such, it gives reliable results on the estimated variability of the starting populations. Sample of 30 seeds per three were separated from the fruit and scanned. Each seed is assigned 4 landmarks. Seed shape was analyzed using analysis of variance, principal components analysis and canonical discriminant analysis. Analysis of variance revealed statistically significant differences in seed shape and size (centroid size: $F = 48.86$, $p < 0.0001$; shape: $F = 2.45$, $p < 0.0001$). Principal component analysis described a cumulative 69.87% of the variability (PC1=44.05%, PC2=25.81%). Canonical discriminant analysis described 92.50% of the total seed variability (CV1=72.40%, CV2=20.10%). Although there are statistically significant differences between the test trees, the dominance of a particular morphotype is not clearly established. This result may be a consequence of a small sample, as well as an insufficient number of digitized specific points, which represents a challenge for future research. However, the obtained results indicate a high percentage of the described variability, as well as the existence of statistically significant differences between the test trees in terms of seed morphotype. All this indicates the reliability of the application of geometric morphometry in order to assess the variability of seeds of woody species.

Key words: morphotype, test trees, landmarks

I-POS-13

TESTIRANJE AMPLIFIKACIJE NUKLEARNIH MIKROSATELITSKIH MARKERA DIZAJNIRANIH ZA HRASTOVE IZ SEKCIJE Quercus ZA PROCENU GENETIČKE VARIJABILNOSTI POPULACIJE *Q. cerris* L.

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Genetički diverzitet, struktura populacija, kao i stepen hibridizacije se intenzivno proučava u okviru sekcije Quercus, ali jasni podaci o ovim parametrima za populacije Q. cerris (sekcija Cerris) su malobrojni. Uspešnost amplifikacije slika je evolutivne istorije dve različite sekcije i različite akumulacije mutacija između sekcija. U ovom radu testirana je amplifikacija 20 nSSR markera grupisanih u dva prajmer miksa: OM1: PIE239, FIR004, QrZAG90, QrZAG108, MSQ13, GOT004, QrZAG87, QpZAG104, QrZAG11, QrZAG103, QrZAG102; OM2: QpZAG36, QrZAG101, MAQ4, PIE242, QrZAG20, QpZAG1/2, QpZAG58, QrZAG7, QpZAG110. Testiranje je vršeno na populaciji koju reprezentuje 60 individua sa područja Kosmaja, gde je cer u simpatriji sa populacijama *Q. petraea*, *Q. pubescens* i *Q. frainetto*. Ekstrakcija DNK obavljena je iz 20 mg osušenog lista, korišćenjem peqGOLD Plant DNA Mini Kit (PEQLAB). Utvrđivanje dužine produkata PCR amplifikacije obavljeno je korišćenjem programskog paketa GeneMapper v.5. (Applied Biosystems). Uspešna amplifikacija detektovana je na 8 od 20 lokusa: FIR004, PIE239, MSQ13, QrZAG11, QrZAG90, PIE242, QpZAG110 i QrZAG20. Lokusi PIE239 i QrZAG11 su bili monomorfni, a na lokusu QrZAG90 je kod svih individua uočeno prisustvo multiplih produkata amplifikacije. Nulti aleli nisu uočeni samo na lokusu FIR004. Detektovano je ukupno 79 alela, pri čemu je najmanji broj alela uočen na lokusu MSQ13 (6), a najveći na lokusu QpZAG110 (24). Dobijena heterozigotnost iznosila je 0,528 (SE=0,092), a očekivana heterozigotnost 0,778 (SE=0,124). Detektovan je statistički značajan višak homozigota. S obzirom da su podaci o molekularnoj varijabilnosti populacija cera oskudni, a u Srbiji nikada istraživani, ovi rezultati se mogu smatrati dobrom polaznom osnovom za dalja istraživanja.

Ključne reči: cer, nSSRs, izmeđusekcijska amplifikacija

CROSS-AMPLIFICATION OF NUCLEAR MICROSATELLITE MARKERS DESIGNED FOR OAKS FROM THE SECTION Quercus FOR ASSESSING THE GENETIC DIVERSITY OF THE *Q. cerris* L. POPULATION

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Genetic diversity, population structure, and the degree of hybridization are intensively studied within the section Quercus, but clear data on these parameters for *Q. cerris* (section Cerris) are scarce. The success of cross-amplification is a consequence of the different evolutionary history of the sections, as well as the different accumulation of mutations. In this paper we tested the amplification of 20 nSSR markers grouped in two primer mixes: OM1: PIE239, FIR004, QrZAG90, QrZAG108, MSQ13, GOT004, QrZAG87, QpZAG104, QrZAG11, QrZAG103, QrZAG102; OM2: QpZAG36, QrZAG101, MAQ4, PIE242, QrZAG20, QpZAG1/2, QpZAG58, QrZAG7, QpZAG110. Studied population is represented by 60 *Q. cerris* individuals from Mt Kosmaj (Serbia). DNA extraction from cca. 20 mg of dried leaf was performed using the peqGOLD Plant DNA Mini Kit (PEQLAB), and GeneMapper v.5 (Applied Biosystems) was used for sccoring. Successful amplification was detected at 8 of 20 loci: FIR004, PIE239, MSQ13, QrZAG11, QrZAG90, PIE242, QpZAG110 and QrZAG20. Loci PIE239 and QrZAG11 were monomorphic. and the presence of multiple amplification products was observed at the QrZAG90 in all individuals. Therefore, the mentioned loci were omitted from further analyses. Null alleles were not observed only at locus FIR004. A total of 79 alleles were detected, lowest at MSQ13(6), highest at QpZAG110 (24). The obtained heterozygosity was 0.528(SE=0,092), and the expected heterozygosity was 0.778(SE=0,124). A statistically significant excess of homozygotes was detected. Considering the lack of information on the molecular variability of *Q. cerris* populations, especially regarding populations in Serbia, these results can be considered a good starting point for further research.

Key words: Turkey oak, nSSRs, cross-amplification

II tematska oblast / Topic II

Savremeni trendovi u oplemenjivanju ratarskih, povrtarskih i lekovitih biljaka

Contemporary trends in the breeding of agricultural, vegetable and medicinal plants

II-PP-01

PRIMENA NOVIH TEHNOLOGIJA U OPLEMENJIVANJU KUKURUZA U INSTITUTU ZA KUKURUZ „ZEMUN POLJE"

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Institut zakukuruz "Zemun Polje" (MRIZP) razvija program oplemenjivanja kukuruza više od 75 godina. Stvaranje novih hibrida, koji po svojim najvažnijim agronomskim osobinama prevazilaze hibride prethodne generacije predstavlja primarni zadatak svakog oplemenjivača kukuruza. Prisustvo ZP hibrida kukuruza na tržištima Republike Srbije, ali i u inostranstvu, zahteva stvaranje hibrida za različite agroklimatske uslove, kao i za različite namene. Spajanje različitih naučno istraživačkih disciplina dovelo je do ubrzanja i povećanja tačnosti procesa oplemenjivanja kukuruza, a samim tim i do smanjenja trajanja ciklusa oplemenjivanja kukuruza u svetu do pet, a u MRIZP-u na 6-7 godina. Od 2014. godine MRIZP uspešno primenjuje program dvostrukih haploida (DH) u oplemenjivanju. Primenom takvog pristupa stvoreno je više od 13.000 novih DH inbred linija. Kao rezultat primene DH tehnologije, registrovan je prvi hibrid ZP 4019. MRIZP intenzivno radi na karakterizaciji najelitnijeg materijala uz pomoć SNP (Single Nucleotide Markers) markera koristeći 25k SNP Ilumina Infinium Arrai. Na ovaj način je ostvaren najpreciziniji uvid u germplazmu oplemenjivača, odnosno određivanjem genetičke udaljenosti (GD). Uz pomoć GD vrednosti povećana je verovatnoća dobijanja superiornih inbred linija i hibrida kukuruza. Već dve sezone MRIZP je započeo Visokoinformativnu fenotipizaciju u polju (HTFP), koristeći RGB i multispektralne kamere zasnovane na dronovima za ekstrakciju i vizuelizaciju podataka po parceli. U ovoj fazi istražujemo mogućnost zamene ručnih merenja (kao što je broj i poleganje biljaka), dok je naš konačni cilj da upotrebimo HTFP za donošenje presudnih odluka za hibrid u našim programima oplemenjivanja.

Ključne reči: oplemenjivanje kukuruza, savremene metode

Zahvalnica: Rad je rezultat istraživanja u okviru ugovora 451-03-47/2023-01/200040 od 17.01.2023. godine, finansiranog od strane Ministarstva nauke, tehnološkog razvoja i inovacija Republike Srbije.

APPLICATION OF NEW TECHNOLOGIES IN MAIZE BREEDING IN MAIZE RESEARCH INSTITUTE "ZEMUNPOLJE"

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Maize Research Institute "ZemunPolje" (MRIZP) develops maize breeding program for more than 75 years. The creation of new hybrids, which by their most important agronomic traits surpass the hybrids of the previous generation, is the primary task of every maize breeder. The presence of ZP maize hybrids on the market of the Republic of Serbia, but also abroad, requires creation of hybrids for different agro-climatic conditions, as well as for different purposes. The merging of various scientific research disciplines contributed to the acceleration and the increase of accuracy of the maize breeding process, and therefore the reduction in duration of maize breeding cycle in the world, to up to five years, and in the MRIZP to 6-7 years. Applying such approach MRIZP has created more than 13,000 new inbred lines since 2014 using double haploid (DH) technology. As a result of the application of DH technology, the first hybrid ZP 4019 was registered. MRIZP has been intensively working on the characterization of the most elite material with the appliance of SNP (Single Nucleotide Markers) markers using the 25kSNP Ilumina Infinium Array. In this way, the most precise insight into the breeders' germplasm was accomplished, i.e. by determining the values of genetic distances (GD). With the help of GD values, the probability of obtaining superior inbred lines and maize hybrids increased. For two seasons MRIZP has started High-throughput field phenotyping (HTFP), using drone-based RGB and multispectral cameras for per plot image data extraction and visualization. At this stage we are exploring possibility of replacing manual measurements (like plant count, plant lodging), while our final goal is to employ HTFP tool for vital decision making regarding hybrids in our breeding programs.

Key words: maize breeding, modern methods

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II-PP-02

UTICAJ ABIOTIČKOG I BIOTIČKOG STRESA NA PROMENU FITOHEMIKALIJA U LISTU I ZRNU KUKURUZA - POSLEDICE PO KVALITET I BEZBEDNOST HRANE

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Upotreba kukuruza u ishrani ljudi i životinja ima široku primenu jer predstavlja izvor različitih fitohemikalija koje povoljno utiču na metaboličke procese. Tokom vegetacije biljka kukuruza izložena je različitim uticajima abiotičkog i biotičkog stresa. Napad jedne od najznačajnijih štetočina kukuruza, larve *Ostrinia nubilalis* zavisi od uslova sredine i može dovesti do smenjenja prinosa i do 30%. Oštećenja nadzemnih delova biljke povećavaju rizik od pojave truleži klipa, jer predstavljaju mesta sekundarne infekcije izazvane različitim patogenim gljivama. Jedna od neophodnih agrotehničkih mera je primena pesticida u poljoprivredi u cilju suzbijanju kako štetočina tako i korova, obezbeđujući stabilan prinosa. S druge strane, primena pesticida, nepovoljni uslovi spoljašnje sredine i biotički stres mogu dovesti do oksidativnog stresa, oštećenja ćelija i pojave slobodnih radikala i reaktivnih vrsta kiseonika (engl. *reactive oxygen species* - ROS). Ćelije i tkiva biljaka imaju razvijene antioksidativne sisteme odbrane koji ihibiraju ili vezuju slobodne radikale. Najznačajniji neenzimski antioksidansi su flavonoidi, fenolne kiseline, karotenoidi, tokoferoli, fitinska kiselina, vitamin C, i glutation. Osim promena u prinosu i antioksidativnom statusu, kod biljke može doći i do promena u količini i drugih fitohemikalija kao što su proteini, šećeri, amnokiseline i masne kiseline. Do sada su nedovljno ispitani uticaji pesticida i abiotički stres koji mogu da izazovu promene na različitim tkivima kukuruza, pri čemu je više pažnje posvećano promeni fitohemikalija izazvanoj uticajem spoljašnje sredine kao što je vodni deficit. U cilju pronalaženja karakterističnog odgovora genotipa, u odnosu na promene fitohemijskog sadržaja, kao i eventualno izdvajanje genotipa tolerantnog na potencijalni stres primenjuju su metode spekrofotometrije i savremene metode tečne i gasne hromatografije za odredjivanje fitohemikalija u biljci.

Ključne reči: štetočine, ROS, fitohemikalije, *Zea mays* L.

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EFFECT OF ABIOTIC AND BIOTIC STRESS ON ALTERATION OF PHYTOCHEMICALS IN MAIZE LEAF AND GRAIN - AFTEREFFECT ON FOOD QUALITY AND SAFETY

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The use of maize in human nutrition and livestock feed is widely used because it is a source of various phytochemicals that have a positive effect on metabolic processes. During the growing season, the maize plant is exposed to various influences of abiotic and biotic stress. *Ostrinia nubilalis* larvae, one of the predominant maize pests, can reduce plant growth and cause stalk and ear damage, leading to a yield decrease of up to 30%. Damage to the above-ground parts of the plant increases the risk of cob rot, presenting sites of secondary infection caused by pathogenic fungi. One of the necessary agrotechnical strategies is the application of pesticides in order to control both pest and weed impact, providing stability of yield. On the other hand, the application of pesticides, negative environmental impacts, and biotic stress can lead to oxidative stress, cell damage and the appearance of free radicals and reactive oxygen species (ROS). Cells and plant tissues have developed antioxidant defense systems that inhibit or bind free radicals. The most important non-enzymatic antioxidants are flavonoids, phenolic acids, carotenoids, tocopherols, phytic acid, vitamin C, and glutathione. In addition to changes in yield and antioxidant status, alteration of other phytochemicals such as proteins, sugars, amino acids and fatty acids can also occur in the plant. The effects of pesticides and abiotic stress that they can cause on different tissues of maize have been insufficiently investigated. More attention has been given to the changes in phytochemicals content caused by the influence of the environment such as water deficit. In order to find the response of the genotype, in relation to changes in the phytochemical content, as well as the eventual selection of a genotype tolerant to potential stress, spectrophotometry methods and modern methods of liquid and gas chromatography were applied to determine phytochemicals in the plant.

Key words: pest, ROS, phytochemicals, *Zea mays* L.

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II-PP-03

CELOGENOMSKA STUDIJA PRIDRUŽIVANJA ZA SADRŽAJ KAROTENOIDA I TOKOLA U PANELU INBRED LINIJA KUKURUZA IZ GEN BANKE

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Karotenoidi i jedinjenja vitamin E (tokoli) pripadaju grupi antioksidansa rastvorljivih u mastima koji se nalaze u zrnu kukuruza u većim količinama. Kukuruz je ciljni usev za biofortifikaciju hrane različitim hranivim supstancama pogotovo pomoću tehnika konvencionalnog oplemenjivanja biljaka koristeći nativnu germplazmu. U ovom radu koristili smo uzorke (inbred linije) kukuruza iz Hrvatske genbanke da bi se detektovali lokusi kvantitativnih svojstava (QTL) za sadržaj luteina, zeaksantina, α i β kriptoksantina, α i β karotena, α, β i γ tokoferola, , α i γ tokotrienola u zrnu. Poljski ogled je uključivao 100 inbred linija kukuruza različitog udela nativne germplazme (sorti kukuruza iz Jugoistočne Europe) postavljen na dve lokacije u Hrvatskoj. Analiza sadržaja karotenoida i tokola obuhvatala je simultanu separaciju i kvantifikaciju pomoću HPLC instrumenta. Genotipizacija uzoraka napravljena je Axiom 600k maize SNP čipom sa ~616000 markera. Genotipski podaci su filtrirani i izvršena je imputacija nedostajućih podataka i heterozigota LinkImpute softverom. Finalni set podataka sastojao se od 460212 markera koji su upotrebljeni za asocijativno mapiranje pomoću mešanog linearnog modela softverom Tassel sa BLUP genotipskim vrednostima i genomskim matricama kao inputima i matricama srodnosti i osnovnih koordinata kao kovarijablama. Prag od 4 proglašen je signifikantnom asocijacijom. Signifikatne asocijacije detekovane su za sve analizirane karotenoide i tokole osim za γ tokoferol na hromosomima 1, 2, 3, 4, 5, 6, 7, 8, 9. Najveće–$\log_{10}$p vrednosti bile su 5.89 za β kriptoksantin na hromosomima 3, 6 i 9, kao i 5.07 za α tokoferol na hromosomu 5. Identifikacija gena kandidata unutar regiona koji nose signifikantne asocijacije će se predstaviti u diskusiji.

Ključne reči: kukuruz, kvalitet, SNP markeri, bioinformatika, hrana

GENOME-WIDE ASSOCIATION STUDY OF CAROTENOID AND TOCOL CONTENT IN A PANEL OF INBRED LINES OF MAIZE FROM A GENBANK

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Carotenoids and vitamin E compounds (tocols) are the two most abundant groups of lipid-soluble antioxidants in maize kernels. Maize represents a key target crop for nutrient biofortification efforts focused on using conventional plant breeding techniques in native germplasm. In this study, we used accessions of temperate maize from Croatian maize genebank (inbred lines) to detect quantitative trait loci (QTL) for contents of lutein, zeaxanthin, α- and β - cryptoxanthin, α- and β -carotene, , α-, β- and γ-tocopherol, α- and γ -tocotrienol in grain. A field trial with 100 maize inbred lines having different proportions of native germplasm (maize landraces from Southeastern Europe) was conducted at two locations in Croatia to analyze carotenoid and tocol content separated and quantified simultaneously using a HPLC instrument. Inbreds were genotyped with Axiom 600k SNP maize genotyping array yielding ~616,000 scored markers. Markers were filtered for missingness and heterozygosity and imputed using a LinkImpute software. Final dataset consisted of 460,212 markers that were used for association mapping (AM). AM was carried out with mixed linear model (MLM) framework in Tassel software with BLUPS of genotypic performances and genomic matrix as inputs and kinship and principal coordinates matrices as covariates. Threshold of 4 was used to declare significant associations. The significant associations were detected for lutein, zeaxanthin, α- and β-cryptoxanthin, α- and β -carotene, α- and β -tocopherol, α - and γ-tocotrienol on chromosomes 1, 2, 3, 4, 5, 6, 7, 8, and 9. There were no significant associations detected for γ-tocopherol. The highest $-\log_{10}p$ values were 5.89 for β-cryptoxanthin on chromosomes 3, 6, and 9, respectively, and 5.07 for α- tocopherol on chromosome 5. Identification of candidate genes within regions carrying the significant associations will be discussed.

Key words: maize, quality, SNP, bioinformatics, food

II-PP-04

MOGU LI "OMICS" TEHNIKE POVEĆATI GENETIČKU DOBIT OD SELEKCIJE?

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Omics tehnike podrazumevaju analize velikih razmera koje se odnose na sveukupnost određenih elemenata živih bića. Iako se ove tehnike rapidno razvijaju, kao što su genomika, transkriptomika i druge, samo jedan deo ovih tehnika je našao primenu u oplemenjivanju biljaka. Genomika svakako predstavlja osnovni moderan alat u genetičkim istraživanjima, kroz različite primene u istraživanjima. Za oplemenjivanje biljaka jedna od najznačajnijih primena genomike je u razvoju modela genomske predikcije, koja omogućava da se isključivo na osnovu genomskih podataka mogu precizno predvideti genetski potecijal pojedinačnih biljaka u određenim proizvodnim uslovima, što omogućava odabir superiornih kandidata za dalji oplemenjivački rad. Visoko propusna fenotipizacija, iako ne spade u klasične omics tehnike, koristi brza i automatska merenja različitih osobina biljaka, kao što su rast, vreme cvetanja, lisna površina i druge. Korišćenjem ovih podataka, uz integraciju sa genomskim podacima, omogućavaju sveobuhvatno razumevanje kako geni deluju na ukupnu fenotipsku varijabilnost. Ovakav pristup omogućava identifikaciju biljaka sa poželjinim osobinam za oplemenjivanje. Fenomska selekcija se proširuje izvan pojedinačnih osobina i uzima u obzir složene intrakcije izeđu više osobina, faktora sredina i genomike. Procenom skupa fenotipskih karakteristika, fenomska selekcija omogućava oplemenjivačima holistički pristup prilikom odabira superiornih biljaka. Sve ove tehnike usmerene su ka unapređenju preciznosti selekije, koja je direktno poroporcionalna genetičkoj dobiti od selekcije. S obzirom na direktnu povezanost, razumljivo je interesovanje istraživača za unapređenje ovog segmenta. Međutim, u novije vreme razvijene se tehnike brzog gajenja biljaka, koje imaju za cilj skraćivanje generacijskog vremena. Takozvane "Speed breeding" tehnike omogućavaju i do 6 generacija godišnje, što rapidno povećava genetičku dobit od selekcije.

Ključne reči: Soja, genetička dobit, genomika

CAN "OMICS" METHODS BOOST THE GENETIC BENEFIT OF SELECTION?

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Omics techniques involve large-scale analyzes related to the totality of certain elements of living beings. Although these techniques are rapidly developing, such as genomics, transcriptomics and others, only a part of these techniques have found application in plant breeding. Genomics certainly represents a basic modern tool in genetic research, through various applications in applied research. One of the most significant uses of genomics in plant breeding is the creation of genomic prediction models, which allow one to select the best candidates for additional breeding work by accurately predicting the genetic potential of specific plants under specific production conditions using only genomic data. Although not a traditional omics technique, high-throughput phenotyping involves quick and automatic measurements of a variety of plant traits, including growth, blooming period, leaf area, and others. These data enable a thorough knowledge of how genes influence overall phenotypic variability, coupled with integration with genomic data. The identification of plants with favorable features for breeding is made possible by this method. Phenomic selection considers complex interactions between numerous characteristics, environmental factors, and genetics in addition to single trait. Phenomic selection gives breeders a holistic approach for choosing superior plants by assessing a set of phenotypic traits. All of these methods work to increase selection accuracy, which directly relates to genetic gain through selection. Given the close relationship, it makes sense that researchers are interested in improving this section. Rapid plant breeding techniques, on the other hand, have recently been created with the aim of reducing the generation time. Up to six generations can be produced annually using so-called "Speed breeding" techniques, which significantly boosts the genetic benefit of selection.

Key words: Soybean, genetic gain, genomics

II-PP-05

PREKO ŠEST DECENIJA POSVEĆENE IZVRSNOSTI OPLEMENJIVANJU LUCERKE: OD PIONIRSKIH POČETAKA DO GENOMSKE ERE

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Oplemeljivanje lucerke u Institutu za ratarstvo i povrtarstvo u Novom Sadu započeto je posle Drugog svetskog rata, korišćenjem autohtonih populacija, primenom masovne selekcije, kao najstarije metode. Osnovu uspešnog oplemenjivanja lucerke čini bogata genetska kolekcija, koja je prikupljana, ne samo od autohtonih populacija iz zemlje, već i razmenom materijala sa domaćim i svetskim naučno-istraživačkim institucijama i gen bankama, kao i kroz učešće istraživača u međunarodnim projektima. Oplemenjivanje lucerke u Institutu traje neprekidno više od šest decenija, kroz nekoliko ciklusa, primenom različitih oplemenjivačkih metoda, što je rezultiralo sa 22 sorte priznate u Srbiji i 9 sorti registrovanih u inostranstvu (EU, Belorusija, Ukrajina, Turska, Maroko). Iz globalne perspektive, kraj 20. i početak 21. veka obeležilo je uvođenje novog koncepta oplemenjivanja lucerke - semihibridno oplemenjivanje, kao jedan od načina da se poveća prinos krme lucerke, a farmeri u narednim godinama mogu očekivati nove, visokoprinosne i visokokvalitetne sorte lucerke. Savremene metoda biotehnologije –molekularni markeri, koji su značajni sa aspekta povećanja efikasnosti oplemenjivanja lucerke, takođe se intenzivno primenjuju u oplemenjivačkom radu. Poslednjih godina, Institut se intenzivnije bavi oplemenjivačkim strategijama vezanim za uvođenje genetičke osnove otpornosti na kisela zemljišta/Al tolerantnost korišćenjem populacija diploidne lucerke (*M. lessingii* Fisch. & C.A.Mey. ex Kar.), što predstavlja prvi pokušaj povećanja tolerantnosti lucerke na kisela zemljišta. U oplemenjivanju lucerke istraživanja su usmerena ka stvaranju sorti visoke produkcije nadzemne biomase, kao i proučavanje dugovečnosti – trajnosti sorti. Ispitivanje kvaliteta, posebno hranljive vrednosti i svarljivosti krme, kao i povećanje nivoa otpornosti na ekonomski značajne bolesti i poleganje lucerke, jedan su od pravaca rada na oplemenjivanju lucerke u Institutu.

Ključne reči: lucerka, oplemenjivanje, Institut za ratarstvo i povrtarstvo

Zahvalnica: Ovo istraživanje je podržalo Ministarstvo nauke, tehnološkog razvoja i inovacija Republike Srbije, broj: 451-03-47/2023-01/200032

OVER SIX DECADES OF EXCELLENCE DEDICATED TO ALFALFA BREEDING: FROM PIONEER BEGINNINGS TO THE GENOMIC ERA

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Breeding of alfalfa at the Institute of Field and Vegetables in Novi Sad began after the World War II, using autochthonous populations, and mass selection, as the oldest breeding method. The basis of successful alfalfa breeding is a rich genetic collection, which was collected not only from indigenous populations, but also by the exchange of genotypes with domestic and foreign research institutions and gene banks, as well as through the participation of researchers in international projects. Alfalfa breeding at the Institute has been going on continuously for more than six decades, through several cycles, using different breeding methods, which resulted in the development of 22 alfalfa cultivars in scribed in Serbia and 9 cultivars released abroad (EU, Belarus, Ukraine, Turkey, Morocco). From a global perspective, the end of the 20th and the beginning of the 21st century was marked by the introduction of a new concept of alfalfa breeding - semi-hybrid breeding, as one of the ways to increase the alfalfa biomass yield, and feed producers can expect the release of new, high-yielding and high-quality cultivars in the coming years. Modern methods of biotechnology - molecular markers, which are significant from the aspect of increasing the efficiency of alfalfa breeding, are also intensively applied in breeding work. In recent years, the Institute has been more intensively dealing with breeding strategies related to the introduction of the genetic basis of acid soil resistance/Al tolerance using diploid alfalfa (*M. caerulea*) populations, which represents the first attempt to increase alfalfa tolerance to acid soils. In alfalfa breeding, research is directed towards the creation of cultivars with high production of biomass, as well as the study of the durability of the varieties. Testing the quality, especially the nutritional value and digestibility of forage, as well as increasing the level of resistance to economically significant diseases and alfalfa lodging, are one of the directions of work on alfalfa breeding at the Institute.

Key words: alfalfa, breeding, Institute of Field and Vegetable Crops

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II-PP-06

EVALUACIJA NOVOKOLEKCIONISANIH LINIJA I POPULACIJA KAO OSNOVA SELEKCIJE PASULJA U INSTITUTU ZA POVRTARSTVO SMEDEREVSKA PALANKA

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U Srbiji i širem regionu, tokom druge polovine 20. veka, programi oplemenjivanja i selekcije pasulja uglavnom su se obavljali s ciljem selekcije genotipova zadovoljavajućeg prinosa i kvaliteta sa determinantnim porastom i jednovremenim sazrevanjem mahuna pogodnih za mehanizovano gajenje i berbu, dok je selekcija novih genotipova indeterminantnog porasta bila samo od sekundarnog značaja. Kao rezultat ovih oplemenjivačkih programa u institutima Srbije (Institut za povrtarstvo Smederevska Palanka, Institut za ratarstvo i povrtarstvo Novi Sad, Institut za poljeprivredu i tehnološka istraživanja Zaječar), u poslednje dve decenije 20. veka registrovan je veći broj novih domaćih sorti. U novije vreme širom sveta, selekcioneri su fokusirani na rešavanje glavnih nedostataka rasprostranjenih tradicionalnih i klasičnih sorti, kao što su ispodprosečni prinosi, osetljivost na najznačajnije prouzrokovače bolesti i štetočine, osetljivost na stress prouzrokovan toplotom i nedostatkom vode (posebno vazdušna suša). Kako bi se pronašla odgovarajuća rešenja za navedene izazove u Institutu za povrtarstvo Smederevska Palanka, postavljen je preliminarni poljski ogled sa ciljem ocenjivanja novopribavljenih linija, populacija i spontanih hibrida. Praćene su: visina biljke, visina prve mahune, broj mahuna po biljci, broj semena po biljci i masa 1000 semena, kao i izračunate osobine i upoređena sa registrovanim sortama Galeb i Biser. U toku vegetacione sezone pasulja u 2023. godini, od 23 ocenjivana uzorka, 4 (X2, X17, X22 i X23), četiri su iskazala zadovoljavajuće vrednosti ispitivanih osobina. Odabrane linije su planirane za buduća istraživanja i evaluacije, skrining na tolerantnost na bakterijske bolesti i ukrštanje sa ciljem dobijanja novih, poboljšanih sorti pasulja.

Ključne reči: *Phaseolus* sp., selekcija, linije, populacije

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EVALUATION OF NEWLY COLLECTED LINES AND POPULATIONS AS THE BASIS OF COMMON BEAN SELECTION IN THE INSTITUTE FOR VEGETABLE CROPS, SMEDEREVSKA PALANKA

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In Serbia and the broader region, during the second half of the 20th century, common bean breeding and selection programs were mostly performed in order to select genotypes of satisfactory yield and quality with determinant growth and simultaneous ripening of pods suitable for mechanized cultivation and harvesting, while the selection of new genotypes of indeterminate growth was only of secondary importance. As a result of these breeding programs in Serbian institutes (Smederevska Palanka, Novi Sad, and Zaječar), a greater number of new domestic varieties were registered in the last two decades of the 20th century. In recent times worldwide, breeders have focused on addressing the main issues of widespread traditional and classic varieties, such as below-average yields, susceptibility to plant diseases and pests, intolerance to heat, and water stress. In order to mitigate such demands at the Institute for Vegetable Crops Smederevska Palanka, a preliminary field trial was set up with the aim of evaluating newly provided landraces, populations, and spontaneous hybrids. Plant height, height of the first pod, number of pods per plant, number of seeds per plant, and mass of 1000 seeds, as well as calculated traits, were measured and compared with registered varieties Galeb and Biser. In the growing season 2023, among the 23 accessions evaluated, 4 (X2, X17, X22, and X23) expressed satisfactory values of examined traits. Selected lines are planned for future research and evaluation, screening for tolerance to bacterial diseases, and crossing with the aim of obtaining new, improved varieties of common beans.

Key words: *Phaseolus* sp., selection, lines, landraces

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II-PP-07

KVALITET SEMENA KRMNIH BILJAKA PROIZVEDENIH U SRBIJI

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U radu je dat pregled rezultata koji se odnose na dormantnost, čuvanje semena, prisustvo patogena i uticaj na kvalitet kod višegodišnjih krmnih trava i leguminoza. Brojna istraživanja u svetu ukazuju da dormantnost semena, ambijentalni uslovi i vreme čuvanja semena nakon žetve, kao i prisustvo patogena na semenu utiču na smanjenje kvaliteta semena ove grupe biljaka. Primenom izlaganja semena kiselinama optimalnih koncentracija u kombinaciji sa trajanjem izlaganja moguće je unaprediti klijavost semena i za više od 25%, kako krmnih trava tako i krmnih leguminoza. Sličan efekat za povećanje klijavosti semena obe grupe biljaka moguće je ostvariti i optimalnim temperaturnim tretmanima. Na semenima višegodišnjih krmnih leguminoza oštećenje semenjače šmirglanjem i/ili u kombinaciji sa temperaturnim kao i kiselinskim tretmanima takođe omogućava povećanje klijavosti. Najzastupljeniji patogeni krmnih trava i leguminoza u zemljištu pri nicanju su *Phythium* spp., *Penicillium* spp., *Aspergillus* spp. i *Fusarium* spp., koji parazitiraju klijance, izazivajući njihovo izumiranje, proređenje useva i neujednačen porast biljaka. Od navedenih patogena semenom se prenose *Penicillium* spp., *Aspergillus* spp. i *Fusarium* spp. Našim istraživanjima je potvrđeno da se ove tri vrste patogena u malom procentu detektovane na semenu, kako za krmne trave tako i za leguminoze.

Ključne reči: dormantnost, patogeni, seme krmnih biljaka

Zahvalnica: Rad je podržan od strane Ministarstva nauke, tehnološkog razvoja i inovacija Republike Srbije, Ugovor br. 451-03-47/2023-01

QUALITY OF FODDER PLANTS SEEDS PRODUCED IN SERBIA

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The research presents an overview of the results related to dormancy, seed storage, the presence of pathogens and the impact on quality in perennial forage grasses and legumes. Numerous researches in the world indicate that seed dormancy, ambient conditions and seed storage time after harvest, as well as the presence of pathogens on the seeds affect the reduction of seed quality of this group of plants. By applying optimal concentrations in combination with the time of exposure of seeds to acids, it is possible to improve seed germination by more than 25%, both forage grasses and forage legumes. A similar effect for increasing seed germination of both groups of plants can also be achieved with optimal temperature treatments. On seeds of perennial fodder legumes, damage to the seed coat by sanding and/or in combination with temperature and acid treatments also gives the possibility to increase germination. *Phythium* spp., *Penicillium* spp., *Aspergillus* spp. and *Fusarium* spp., that parasitize seedlings, causing their extinction, crop thinning and uneven plant growth. Of the mentioned pathogens, *Penicillium* spp., *Aspergillus* spp. and *Fusarium* spp. are transmitted by seeds. Our research has confirmed that these three types of pathogens are detected in a small percentage on seeds, both for forage grasses and legumes.

Key words: dormancy, pathogens, fodder plants seed

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II-PP-08

VARIJABILNOST STAY-GREEN OSOBINA ISTORIJSKOG SETA SORTI PŠENICE

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Usled napretka u oplemenjivanju kao i u samoj biljnoj proizvodnji, prinos zrna pšenice je više nego udvostručen tokom poslednjih nekoliko decenija u Jugoistočnoj Evropi kao i u Republici Srbiji. Takođe, ranija istraživanja su ustanovila vezu između dinamike starenja i glavnih komponenti prinosa zrna i drugih agronomskih osobina kod pšenice. Ubrzanjem starenja biljke skraćuje se period nalivanja zrna što može imati negativan uticaj na konačnu masu zrna ukoliko su mehanizmi za eksploatisanje resursa stečenih u fotosintetskom periodu nedostupni. Zbog navedenog, stay-green fenotip pšenice bi mogao da bude jedan od ciljeva u oplemenjivanju, budući da je duže trajanje zelene lisne površine povezano sa mehanizmima i osobinama koje ublažavaju negativan uticaj spoljne sredine tokom perioda nalivanja zrna. U cilju utvrđivanja varijabilnosti stay-green osobina tokom više godina kontinuirano su praćeni različiti vegetacioni indeksi kod istorijskog seta sorti pšenice. Ustanovljena je varijabilnost ispitivanih stay-green osobina između odabranih sorti i pozitivna linearna korelacija sa godinom priznavanja. Takođe, rezultati ogleda su pokazali veće vrednosti stay-green osobina kod modernih sorti pšenice što pokazuje njihovu sposobnost da duže vremena ostanu zelene i duže održe fotosintetsku aktivnost. U proseku, starijim sortama je bilo potrebno više akumuliranih termalnih jedinica da bi stupile u fazu klasanja u odnosu na moderne sorte. Primena savremenih senzora u oplemenjivanju omogućuje redovno praćenje dinamike starenja zelene lisne površine nakon cvetanja radi odabira genotipova koji imaju sposobnost dužeg zadržavanja zelene lisne površine a samim tim i produženu fotosintetsku aktivnost i nalivanje zrna.

Ključne reči: pšenica (*Triticum aestivum* L.), stay-green, varijabilnost

Zahvalnica: Sredstva za realizaciju istraživanja obezbeđena su od strane Ministarstva nauke, tehnološkog razvoja i inovacija Republike Srbije (Br. ugovora: 451-03-47/2023-01/200032) i Pokrajinskog sekretarijata za visoko obrazovanje i naučnoistraživačku delatnost Autonomne pokrajine Vojvodine (Br. projekta: 142-451-3152/2022-01/2).

THE VARIABILITY IN STAY-GREEN TRAITS OF THE HISTORICAL SET OF WHEAT CULTIVARS

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Due to the progress in both plant breeding and crop production, over the last few decades wheat grain yield has more than doubled in southeastern Europe, as in the Republic of Serbia. Also, earlier studies have reported the relationship between senescence dynamics and grain yield main components, along with other agronomic wheat traits. Acceleration of plant senescence reduces the duration of grain filling, and may have a negative impact on the final grain weight if the mechanisms to exploit the resources gained during the photosynthetic period are unavailable. Therefore, a stay-green phenotype could be one of the breeding aims, since the longer duration of green leaf area is related to mechanisms and traits that alleviate negative environmental effects during the grain filling. In order to determine the variability of stay-green traits, over several years, various vegetative indexes were continuously monitored in a historical set of wheat cultivars. Variation in the examined stay-green traits and a positive correlation with the year of registration was found. Moreover, the results showed higher values of the stay-green traits in modern cultivars, indicating their ability to stay green and maintain photosynthetic activity for a longer period. On average, older cultivars needed more accumulated thermal time for anthesis than the modern cultivars. The application of modern sensors in breeding enables regular monitoring of green leaf area senescence dynamics after anthesis, in order to select genotypes that have the ability to retain green leaf area for a longer period, and therefore extend photosynthetic activity and grain filling.

Key words: wheat (*Triticum aestivum* L.), stay-green, variability

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II-PP-09

SKRINING TOLERANTNOSTI NA SALINITET GERMPLAZME PŠENICE GAJENE NA SOLONJECU

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Usled ljudskih aktivnosti, zaslanjenost zemljišta postaje glavni izazov za globalnu proizvodnju hrane. Pšenica je osnovna namirnica za veliki deo svetske populacije, a stres zaslanjenosti predstavlja značajnu pretnju njenoj produktivnosti. Stoga je stvaranje tolerantnih genotipova pšenice na salinitet od vitalnog značaja za obezbeđivanje održive proizvodnje hrane, posebno u područjima pogođenim stresom saliniteta zemljišta. Proučavanje genotipova pšenice u poljskim uslovima povećane zaslanjenosti je ključno za efikasnu identifikaciju genotipova tolerantnih na salinitet. U skladu sa tim, procenjena je tolerantnost 27 genotipova pšenice na salinitet na solonjecu u uslovima saliniteta i černozemu kao kontroli tokom dve vegetacione sezone. Masa zrna po klasu, koja je smanjena za 35% u uslovima saliniteta zemljišta, najbolji je fenotipski marker uticaja zaslanjenosti na biljku. Takođe, povećana zaslanjenost zemljišta je smanjila vrednosti broja zrna po klasu, mase klasa i prinosa zrna za 30%. Sprovedena je klaster hitmap analiza, koja je omogućila hijerarhijsko grupisanje genotipova, odnosno osobina. Masa hiljadu zrna, na koju je dominantan efekat imao faktor godina, svrstana je u posebnu klaster grupu. U uslovima solonjeca, genotipovi Harmonija, Renesansa, Orašanka, KG-58, Bankut 1205 i Oplenka su grupisani u okviru iste klaster grupe, dok su u uslovima černozema usko povezani genotipovi Renesansa i Jugoslavija, ispoljavajući najveće prosečne vrednosti ispitivanih osobina. Na osnovu AMMI analize, genotip Harmonija pokazuje visoku stabilnost prinosa zrna na solonjecu i ocenjen je kao genotip tolerantan na salinitet. Genotip Renesansa je ispoljio visoku stabilnost u svim agroekološkim sredinama i ostvario najveći prinos zrna na černozemu.

Ključne reči: tolerantnost, salinitet, stabilnost, fenotipski markeri, solonjec, černozem

Zahvalnica: Istraživanje je realizovano uz finansijsku podršku Ministarstva nauke, tehnološkog razvoja i inovacija Republike Srbije, brojevi ugovora: 451-03-47/2023-01/200054; 451-03-47/2023-01/200117; 451-03-47/2023-01/200032 i 451-03-47/2023-01/200216; i projekta TR 31092 (MPNTR RS).

SALINITY TOLERANCE SCREENING OF WHEAT GERMPLASM GROWN ON SOLONETZ

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Soil salinity is becoming a major challenge for global food production due to human activities. Wheat is a staple food for a large portion of the global population, and salt stress is a significant threat to its productivity. Therefore, the development of salt-tolerant and high-yielding wheat genotypes is vital for ensuring sustainable food production, especially in areas affected by soil salinity stress. Consideration of wheat genotypes under field salinity conditions is crucial for effectively identifying salt-tolerant varieties. The salinity tolerance of 27 wheat genotypes was assessed under field conditions by establishing an experiment on Solonetz, for salinity conditions, and Chernozem, as the control, during two growing seasons. The grain weight per spike, which decreased by 35% under soil salinity conditions, is the best phenotypic marker of the influence of salinity on the plant. Also, soil salinity reduced the values of the number of grains per spike, spike weight, and grain yield by 30%. Cluster heatmap analysis was performed, which enabled hierarchical clustering of genotypes and traits. The thousand grain weight, primarily influenced by year, is classified into a separate cluster group. On Solonetz, the genotypes Harmonija, Renesansa, Orašanka, KG-58, Bankut 1205, and Oplenka were grouped together, and on Chernozem, Renesansa and Jugoslavija were closely grouped, showing the highest average trait values. Based on the AMMI analysis, the genotype Harmonija exhibits high grain yield stability on Solonetz and was identified as the salt-tolerant genotype. The genotype Renesansa showed high stability in all environments and achieved the highest grain yield on Chernozem.

Key words: salinity tolerance, stability, phenotypic markers, solonetz, chernozem

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II-PP-10

INOVATIVNE STRATEGIJE U UZGOJU SUNCOKRETA TOLERANTNOG U USLOVIMA KLIMATSKIH PROMENA

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Suncokret je najznačajnija uljarica u Srbiji i četvrta po važnosti u svetu. Oplemenjivanje suncokreta u Institutu za ratarstvo i povrtarstvo ima tradiciju dugu preko pet decenija. U toku ovog perioda glavni ciljevi oplemenjivanja su bili povećanje prinosa semena i ulja, kao i tolerantnosti na biotički stres. U današnje vreme, sa klimatskim promenama koje ugrožavaju proizvodnju suncokreta, povećanje tolerancije na abiotički stres postaje važan cilj u oplemenjivanju. Suša kao glavni abiotički stres izaziva odgovor biljaka na različitim nivoima: morfološkom, fiziološkom, biohemijskom i molekularnom. Na molekularnom nivou izaziva promene u ekspresiji gena, akumulaciju različitih metabolita i sintezu specifičnih proteina. Pošto je tolerantnost na sušu složena kvantitativna osobina, potrebno je korišćenje sveobuhvatnog pristupa za otkrivanje mehanizama koje suncokret razvija da bi se izborio sa stresom. Kako bi ispitali tolerantnost na sušu, odabrali smo genotipove suncokreta iz naše velike kolekcije i izvršili opsežnu fenotipizaciju u *in vitro* uslovima kako bismo identifikovali genotipove tolerantne na sušu, kao i osobine koje mogu biti najbolji pokazatelji tolerantnosti. Transkriptom najtolerantnijeg i najosjetljivijeg genotipa pružiće uvid u aktivaciju/deaktivaciju gena tokom izlaganja suši, dok će analiza epigenoma suncokreta pružiti uvid u mehanizme koje biljke razvijaju kako bi brzo odgovorile na sušu i prilagodile se abiotičkom stresu. Konačni cilj je da se identifikuju QTL-ovi i epiQTL-ovi koji mogu da se koriste u oplemenjivanju suncokreta tolerantnog na sušu.

Ključne reči: *Helianthus annuus* L., suša, epigenetika, transkriptomika

Zahvalnica: Ovo istraživanje je podržano CROPINNO projektom br. 101059784 koji finansira Evropska komisija, potom projektom IDEJA „Creating climate smart sunflower for future challenges“ (SMARTSUN) broj 7732457 finansiran od strane Fonda za nauku Republike Srbije, kao i COST Akcijama „Epigenetic Mechanisms of Crop Adaptation to Climate Change” (EPICATCH) - CA19125 i Genome editing in plants - a technology with transformative potential“ PlantEd - CA18111. Istraživanje je sprovedeno u okviru aktivnosti Centra izvrsnosti za inovacije u oplemenjivanju klimatski otpornih useva – CLIMATE CROPS, Instituta za ratarstvo i povrtarstvo, Novi Sad, Srbija. Takođe je deo projekta koji podržava Ministarstvo nauke, tehnološkog razvoja i inovacija Republike Srbije, broj 451-03-47/2023-01/200032.

INNOVATIVE STRATEGIES IN BREEDING CLIMATE RESILIENT SUNFLOWER

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Sunflower is the most important oil crop in Serbia and the fourth most important oil crop worldwide. There is a five decade-long tradition of sunflower breeding at the Institute of Field and Vegetable Crops. Besides the main breeding objectives such as breeding for high seed and oil yield, enhancing biotic stress tolerance has been one of the priorities throughout the past. Nowadays with the climate change jeopardizing sunflower production, increasing abiotic stress tolerance is becoming an important breeding goal. Drought as a major abiotic stress induces plant response on different levels: morphological, physiological, biochemical and molecular. On molecular level it causes alteration in gene expression, accumulation of different metabolites and synthesis of specific proteins. As drought tolerance is such a complex quantitative trait, it requires exploiting a holistic approach for the detection of mechanisms sunflower develops to withstand it. We have thus established a sunflower panel from our substantial sunflower collection and performed extensive phenotyping in *in vitro* conditions in order to identify drought tolerant and sensitive genotypes, as well traits that can be the best indicators of tolerance. Transcriptome of the most tolerant and sensitive genotype will provide insight into gene activation/deactivation during exposure to drought, while analysis of sunflower epigenome will provide insight into mechanisms plants develop to quickly respond to drought and adjust to abiotic stress. Final goal is to identify QTLs and epiQTLs that may be promising in breeding sunflower tolerant to drought.

Key words: *Helianthus annuus* L., drought, epigenetics, transcriptomics

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II-PP-11

GENETIČKA VARIJABILNOST BILJNIH VRSTA - NEPRESUŠNI IZVOR INSPIRACIJE ZA SELEKCIONERE

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Moderna selekcija biljaka je imala neverovatno veliki uticaj na porast poljoprivredne proizvodnje, a i dalje ima značajnu ulogu u obezbeđivanju prehrambene bezbednosti. Selekcioneri su oduvek iskorišćavali genetičku varijabilnost između i unutar različitih biljnih vrsta i kombinovali željene karakteristike da bi kreirali nove i poboljšane sorte. Genetička varijabilnost je osnova za uvođenje novih svojstava u selekcijone programe. Sa druge strane, uspešna proizvodnja elitnih sorti u cilju kreiranja genotipova željenog ideotipa je doprinela smanjivanju genetičkog diverziteta. Za održivu poljoprivrednu proizvodnju potrebno je naći kompromis između maksimiziranja prinosa poljoprivrednih vrsta u uslovima klimatskih promena i minimizacije negativnih efekata koje bi nepovoljni uslovi gajenja imali na prinos. Za ovakav kompromis potrebno je bolje razumeti uticaj koji oplemenjivanje biljaka ima na genetičku varijabilnost, a istovremeno i znati kako identifikovati, inducirati, promeniti i uspešno inkorporirati genetičku varijabilnost u procesu kreiranja novih, poboljšanih sorti. U datom radu je predstavljeno kako genetička varijabilnost može biti iskorišćena za poboljšanje poljoprivrednih vrsta, uz korišćenje ogromnog genetičkog diverziteta koji postoji kod biljnih populacija. Predstavljeni su glavni faktori koje oplemnjivači uzimaju u obzir u različitim fazama oplemenjivanja i selekcije biljaka kao i glavni izazovi sa kojima se oplemenjivači suočavaju u procesu inkorporacije genetičke varijabilnosti u komercijalne sorte. Zaključeno je da je i dalje potreban dug vremenski period za kreiranje novih sorti čak i u slučajevima kada se koriste napredne tehnologije u različitim fazama oplemenjivanja i selekcije biljaka.

Ključne reči: genetička varijabilnost, izazovi, klasična selekcija biljaka, moderna selekcija biljaka

GENETIC VARIABILITY OF CROP SPECIES - AN INFINITE SOURCE OF INSPIRATION FOR PLANT BREEDERS

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Modern plant breeding has had an immense impact on food production and will continue to play a major role in ensuring food security and safety. Plant breeders have always exploited the genetic variability between and within different plant species and combined the desired characteristics to produce new and improved crop varieties. Genetic variability is the basis for the introduction of new traits in breeding programs. On the other hand, the successful production of elite varieties with the aim of creating specific ideotypes contributed to the reduction of the genetic diversity of populations. For sustainable agricultural production, it is necessary to find a compromise between maximizing the yield of agricultural crops in the conditions of constant climate change and minimizing the negative effects that the unfavorable growing conditions would have on yield. For such a compromise, it is essential to better understand the impact that plant breeding has on genetic variability, and at the same time to know how to find, recognize, induce, change and successfully incorporate genetic variability in the process of creating new, improved varieties. This review presents how genetic variability can be used to improve agricultural crops by exploiting the enormous genetic diversity that exists in plant populations, explaining the main challenges that plant breeders face in the process of incorporating desired genetic variability into commercial varieties, the long time required to create new varieties even when advanced breeding technologies are used and the main factors that breeders take into account at different stages of crop improvement.

Key words: genetic variability, challenges, classical plant selection, modern plant selection

II-PP-12

UTICAJ SINHRONIZACIJE POLINACIJE I SVILANJA NA PRINOS ZRNA KUKURUZA U RAZLIČITIM AGROEKOLOŠKIM USLOVIMA

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Važan cilj oplemenjivača kukuruza je da poboljšaju stabilnost performansi kukuruza kada je izložen različitim vrstama abiotskih stresova. Cilj ove studije bio je da se proceni odgovor genotipa na smanjenje *anthesis-silking* intervala (ASI) na devet lokacija u Rumuniji, Mađarskoj i Srbiji u uslovima suše i povoljnih uslova, pri čemu je osam sredina bilo izloženo toploti i stresu od suše. Dvofaktorijalni poljski ogledi po kompletno randomiziranom blok dizajnu su postavljeni 2022. godine, u tri ponavljan sa 28 hibrida. Na lokacijama gde su tokom cvetanja primećeni toplotni i sušni stres, između prinosa zrna i ASI opsega korelacije su bile od -0,34 do 0,23 dok je korelacija 0,64 dobijena na lokaciji bez evidentiranog stresa. Zbog značaja ove vrste istraživanja neophodno je da se rad na datim istraživanjima nastavi sa ciljem da se poveća tačnost u proceni abiotskih stresova i njihovog uticaja na plodnost i prinos zrna.

Ključne reči: interval metlanje-svilanje, toplotni i sušni stres, sinhronizacija muškog i ženskog cvetanja, kukuruz, prinos zrna

INFLUENCE OF POLLINATION AND SILKING SYNCHRONIZATION ON MAIZE GRAIN YIELD ACROSS DIFFERENT AGROECOLOGICAL CONDITIONS

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An important goal of maize breeders has been to enhance the stability of performance of maize when exposed to diffrent kind of abiotic stresses.The objective of this study was to evaluate genotype response for reduced anthesis-silking interval (ASI) across 9 locations in Romania, Hungary and Serbia under drought and favorable conditions, while eight environments were exposed to heat and drought stress.Field experiments with two factorial randomized complete blocks were established in 2022, with 3 replications and 28 hybrids. On the locations where heat and drought stress were observed during flowering, between grain yield and (ASI) range of correlations were from -0.34 to 0.23 while correlations 0.64 was obtained on the location without notified stress. Due to the importance of this kind of research neccessity is to expand longevity of trials with the aim to increase accuracy in evaluation of abiotic stresses and their effects on fecundation and grain yield.

Key words: anthesis-silking interval, heat and drought stress, male and female flowering synchronization, maize, grain yield

II-USM-13

KARAKTERIZACIJA KUKURUZNOG SKROBA KAO PRODUKTA MOKROG MLEVENJA ZRNA U CILJU NJEGOVE UPOTREBE U PREHRAMBENOJ INDUSTRIJI

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Skrob je glavna komponenta zrna kukuruza koja se akumulira u endospermu i čini oko 70% suve materije. U ovom radu, sa ciljem određivanja mogućnosti primene u prehrambenoj industiji, vršena je karakterizacija skroba deset odabranih genotipova (šest genotipova standardnog zrna žute boje, tri voskovca i jedan genotip standardnog zrna crvene boje). Skrob je izolovan laboratorijskim procesom mokrog mlevenja, pri čemu je određen prinos skroba i sporednih proizvoda (gluten, klica, mekinje, procesna voda i voda od močenja), sadržaj proteina, procenat iskorišćenja skroba, *in vitro* svarljivost kao i parametri želatinizacije. Stepen iskorišćenja skroba kretao se od 70,31% (ZP 6073wx) do 90,84% (ZP 299). Skrob sedam genotipova standardnog zrna imao je očekivan sadržaj amiloze (20-24%), dok su tri voskovca imala očekivan sadržaj amilopektina (100%). Enzimskom metodom je utvrđeno da je skrob poreklom od genotipova voskovaca ispoljio viši stepen svarjivosti u odnosu na skrob genotipova standardnog zrna. Najvišu moć bubrenja imao je amilopektinski skrob genotipa ZP 6066wx (13,12%), najviši indeks rastvorljivosti genotip ZP 704wx (20,50%) dok je kod genotipa standardnog zrna crvene boje najviši bio stepen apsorpcije vode (12,74%). Pokazalo se da postoji korelacija između parametara želatinizacije i svarljivosti skroba, pri čemusu viši stepen svarljivosti imali amilopektinski skrobovi u poređenju sa skrobovima standardnog zrna. Ostvareni rezultati ukazuju na široke mogućnosti primene kukuruzuznog skroba u prehrambenoj industriji budući da se savremeni trendovi ne baziraju isključivo na upotrebi skroba kao sastojka hrane već i kao komponente ekološki prihvatljive, jestive, biorazgradive ambalaže.

Ključne reči: kukuruzni skrob, mokro mlevenje, *in vitro* svarljivost, želatinizacija, industrijska primena

Zahvalnica: Istraživanje je podržalo Ministarstvo nauke, tehnološkog razvoja i inovacija Republike Srbije (Grant br. 451-03-47/2023-01/200040).

CHARACTERIZATION OF MAIZE STARCH AS A PRODUCT OF WET GRAIN MILLING FOR ITS USE IN THE FOOD INDUSTRY

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Starch is the main component of maize grains and makes up about 70% of the dry matter. In this study, with the aim of determining the possibility of application in the food industry, the characterization of the starch of ten selected genotypes was carried out (six genotypes of standard yellow grain, three waxy and one genotype of standard red grain). Starch was isolated by a laboratory wet milling process, the yield of starch and co-products (gluten, germ, bran, process water and CSL), protein content, percentage of starch utilization, *in vitro* digestibility and gelatinization parameters were determined. The degree of starch utilization ranged from 70.31% (ZP 6073wx) to 90.84% (ZP 299). The starch of the standard grain and waxy had the expected amylose and amylopectincontent (20-24%) and (100%), respectively. It was determined that the starch originating from the waxy genotypes exhibited a higher degree of digestibility compared to the starch of standard grain. The highest swelling power was determined in the genotype ZP 6066wx (13.12%), the highest solubility index was the genotype ZP 704wx (20.50%), the standard red grain had the highest water absorption index (12.74%). There is a correlation between gelatinization parameters and starch digestibility, where amylopectin starches having a higher degree of digestibility compared to standard grain starches. The achieved results indicate the wide possibilities of applying maize starch in the food industry, since modern trends are not based exclusively on the use of starch as a food ingredient, but also as a component of environmentally friendly, edible, biodegradable packaging.

Key words: maize starch, wet milling, *in* vitro digestibility, gelatinization, industrial application

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II-USM-14

MEĐUZAVISNOST PRINOSA ZRNA, POSEBNIH KOMBINACIONIH SPOSOBNOSTI I HETEROZISA U ODNOSU NA BOLJEG RODITELJA KOD F_1 HIBRIDA KUKURUZA

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Kukuruz je jedna od najrasprostranjenijih žitarica kako u svetu tako i u Srbiji i odlikuje se velikim genetičkim potencijalom rodnosti zrna. Danas se velika pažnja poklanja oplemenjivanju na povećan prinos zrna i stvaranju novih visokorodnih hibrida. Jedna od najpoželjnijih osobina kod hibrida kukuruza je stabilnost prinosa zrna na osnovu čega se on preporučuje za dalju upotrebu i proizvodnju. Cilj rada je da se odredi variranje u prinosu između genotipova kao i da se na osnovu koeficijenta korelacije utvrdi međusobna povezanost prinosa zrna, posebnih kombinacionih sposobnosti (PKS) i heterozisa u odnosu na boljeg roditelja. U istraživanju je korišćeno 7 inbred linija kukuruza koje su međusobno ukrštene po metodu dialela čime je dobijen 21 hibrid. Ogled je postavljen na tri lokacije u periodu od dve godine. Na osnovu prinosa zrna inbred linija i hibrida izračunat je heterozis u odnosu na boljeg roditelja i posebne kombinacione sposobnosti. Najviše srednje vrednosti prinosa zrna ostvarile su inbred linije ZPL6 (4.17 t/ha) i ZPL4 (4.16 t/ha), dok su od hibrida najprinosniji bili ZPL2 x ZPL4 (11.15 t/ha) i ZPL1 x ZPL4 (10.79 t/ha). Najviša vrednost heterozisa (285.88%) kao i vrednost PKS (2.061) za prinos zrna dobijena je kod hibrida ZPL2 x ZPL4. Koeficijent korelacije između prinosa zrna i posebnih kombinacionih sposobnosti (0,85), kao i između prinosa i heterozisa u odnosu na boljeg roditelja (0,93) je bio visok i veoma statistički značajan. Na osnovu dobijenih rezultata se može zaključiti da su dobre kombinacione sposobnosti inbred linija i izražen heterozis preduslov za dobijanje prinosnih i ekonomski isplativih hibrida kukuruza.

Ključne reči: prinos, heterozis, kombinacione sposobnosti

Zahvalnica: Ovo istraživanje finansirano je od strane Ministarstva nauke, tehnološkog razvoja i inovacija Republike Srbije (broj ugovora: 451-03-47/2023-01/200040).

CORRELATION BETWEEN GRAIN YIELD, SPECIFIC COMBINING ABILITIES AND BETTER PARENT HETEROSIS IN F_1 MAIZE HYBRIDS

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Maize is one of the most widely grown cereals in the world, as well as in Serbia, and it has a high genetic potential for grain yield. Today, a lot of focus is placed on improving grain yield and developing new high-yielding hybrids. One of the most desirable characteristics of maize hybrids is grain yield stability, which is why it is recommended for continuing usage and production. The aim of the work is to determine the variation in yield between genotypes, as well as to determine the correlation between grain yield, specific combining abilities (SCA) and better parent heterosis. In the study, 7 inbred lines of maize were crossed with each other using the dialel method, resulting in 21 hybrids. Over a two-year period, the experiment was set up in three separate locations. The grain yield of inbred lines and hybrids was used to calculate better parent heterosis and specific combining abilities. The highest average grain yield values were obtained by inbred lines ZPL6 (4.17 t/ha) and ZPL4 (4.16 t/ha), whereas the most productive hybrids were ZPL2 x ZPL4 (11.15 t/ha) and ZPL1 x ZPL4 (10.79 t/ha). The ZPL2 x ZPL4 hybrid has the highest heterosis value (285.88%) and PKS value (2.061) for grain yield. The correlation coefficient between grain yield and specific combining abilities (0.85), as well as between grain yield and better parent heterosis (0.93) was high and highly statistically significant. Based on the results, it is possible to conclude that superior combining abilities of inbred lines and expressed heterosis are required for the development of high-yielding and economically profitable maize hybrids.

Key words: yield, heterosis, combining abilities

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II-USM-15

POTENCIJAL KOMERCIJALNIH HIBRIDA KUKURUZA ZA FORMIRANJE AKRILAMIDA

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Kukuruz (*Zea mais L.*) je jedan od najsvestranijih useva za ishranu ljudi u brojnim zemljama i može se uzgajati u različitim uslovima životne sredine i ima raznovrsnu upotrebu kao hrana za ljude. Kukuruz mora biti termički obrađen za ishranu, što stvara rizik od kontaminacije. Jedan od kontaminenata je akrilamid, koji je najverovatnije kancerogen za ljude. Cilj ovog rada bio je da se utvrdi potencijal komercijalnih hibrida za formiranje akrilamida u hrani, odnosno da se analizira sadržaj prekursora akrilamida – sadržaj slobodnog asparagina i redukujućih šećera. Ova studija je obuhvatila devetnaest genotipova kukuruza gajenih 2021. i 2022. godine. Biljni materijal razvijen u MRIZP-u obuhvatao je četrnaest genotipova standardnog zrna, jedan beli kukuruz, tri kokičara i jedan genotip kukuruza šećerca. Rezultati su pokazali da nije bilo statistički značajne razlike između dve godine u pogledu sadržaja slobodnog asparagina, ali se uticaj spoljašnje sredine odrazio na sadržaj šećera. Sadržaj fruktoze, glukoze, saharoze i maltoze bio je oko 42%, 21%, 31%, odnosno 33% manji kod genotipova uzgajanih 2022. godine. Genotipovi su se statistički razlikovali na osnovu detekcije slobodnog asparagina i sadržaja šećera. Prema sadržaju slobodnog asparagina mogu se razlikovati tri grupe genotipova. Četiri genotipa su imala sadržaj asparagina od 200-300 μg/kg, jedanaest genotipova je imalo 300-400 μg/kg, a još četiri genotipa su imala više od 400 μg/kg. ZP427 je imao najveći potencijal za proizvodnju akrilamida, dok je ZP504su imao 50% manji sadržaj aparagina.

Ključne reči: kukuruz, akrilamid, asparagin, šećeri, HPLC

Zahvalnica: Ovu studiju je podržalo Ministarstvo za nauku, tehnološki razvoj i inovacije Republike Srbije (Grant br. 451-03-47/2023-01/200040).]

POTENTIAL OF COMMERCIAL CORN HYBRIDS FOR ACRYLAMIDE FORMATION

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Maize (*Zea mays L.*) is one of the most versatile human food crop in a number of countries crops and can be grown in diverse environmental conditions and has diversified uses as human food. Maize must be thermally processed into food, which creates a risk of contamination. One of the contaminants is acrylamide, which is probably carcinogenic to humans. The aim of this work was to determine the potential of commercial hybrids for the formation of acrylamide in food i.e. to analysis the content of acrylamide precursors - free-asparagine and reducing sugar content. This study included a nineteen maize genotypes grown during the seasons of 2021 and 2022. The plant material developed at the MRIZP encompassed fourteen yellow dent, one white dent, three popping, and one sweet maize genotype. The results showed that there was no statistically significant difference between the two years in terms of asparagine content, however the effect of the environment conditions was reflected in the sugar content. The content of fructose, glucose, sucrose, and maltose was approximately 42%, 21%, 31%, and 33% lower in genotypes cultivated in 2022, respectively. The genotypes were statistically different based on the detection of the free-asparagine and sugar content. According to the content of free-asparagine, three groups of genotypes can be distinguished. Four genotypes had an asparagine content of 200-300 μg/kg, eleven genotypes had 300-400 μg/kg, and another four genotypes had more than 400 μg/kg. ZP427 had the largest potential for acrylamide production, while ZP504su had a 50% lower aparagine content.

Key words: maize, acrylamide, asparagine, sugar, HPLC

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II-USM-16

DINAMIKA NAKUPLJANJA SUVE MATERIJE U ZRNU HIBRIDA KUKURUZA RAZLIČITIH GRUPA ZRENJA

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Cilj ovog rada je bio da se u datim agroekološkim uslovima ispitaju dinamika nakupljanja suve materije u zrnu i visina prinosa u zavisnosti od hibrida kukuruza različite dužine vegetacije. Ogled je postavljen po RCB dizajnu sa 12 hibrida, u četiri ponavljanja, na oglednom polju Rimski Šančevi, Instituta za ratarstvo i povrtarstvo. Praćenje dinamike nakupljanja suve materije u zrnu je vršeno u periodu od svilanja do fiziološke zrelosti, na svaka tri dana, za svaki hibrid. Prikupljeni podaci o dinamici suve materije u zrnu su analizirani u programu SegReg. Na osnovu vremenske analize, kod svih hibrida je nakupljanje suve materije pratilo linearni trend do maksimuma tj. prelomne tačke, od koje se sadržaj suve materije nije menjao. Kod najranijeg hibrida (NS-1) je maksimalni sadržaj suve materije (0.255g) postignut 39 dana nakon svilanja (DNS), dok je kod najkasnijeg hibrida (NS-12) maksimalni sadržaj suve materije iznosio 0.249g i postignut je 42 DNS. Dinamika nakupljanja suve materije je bila najbrža kod hibrida NS-4, koji je za 35 DNS dostigao maksimalni sadržaj suve materije u zrnu od 0.244g. Hibrid NS-2 je ostvario najveću suvu materiju zrna (0.288g), a hirbid NS-5 najmanju suvu materiju zrna (0.210g). Najveći prinos zabeležen je kod hibrida NS-5 (8.12 tha^{-1}), dok je najmanji prinos zabeležen kod hibrida NS-12 (4.68 tha^{-1}). Rezultati ovog ogleda omogućavaju bolje razumevanje dinamike nakupljanja suve materije kod hibrida kukuruza i mogu poslužiti kao dobar pokazatelj optimalnog vremena žetve.

Ključne reči: kukuruz, nalivanje zrna, prinos, *Zea mays* L.

DYNAMICS OF GRAIN DRY MATTER ACCUMULATION WITHIN DIFFERENT MATURITY GROUPS OF MAIZE HYBRIDS

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The aim of this study was to examine the dynamics of dry matter accumulation in the grains of maize hybrids of different maturity groups and their yield in the provided agroecological conditions. The trial was organised as a RCB design, with 12 hybrids in four replications, and was conducted at the Rimski Šančevi experimental field of Institute of Field and Vegetable Crops in Novi Sad (IFVCNS). The progression of dry matter accumulation in the grain was monitored in the period from silking to physiological maturity, at three-day intervals, for each hybrid. Collected data were analyzed in the SegReg program. The dry matter accumulation followed a linear trend until the breaking point (linear plateu regression), from which its content remained stable. The earliest hybrid (NS-1) achieved the maximum dry matter content (0.255g) at 39 days after silking (DAS), while the latest hybrid (NS-12) reached its maximum dry matter content (0.249g) at 42 DAS. The dynamics of dry matter accumulation was the fastest in hybrid NS-4, which attained its peak grain dry matter content of 0.244g at 35 DAS. NS-2 achieved the highest grain dry matter (0.288g), and hybrid NS-5 the lowest grain dry matter (0.210g). In terms of overall yield, the highest yield was recorded in hybrid NS-5 (8.12 tha^{-1}), while the lowest yield was recorded in hybrid NS-12 (4.68 tha^{-1}). These experimental results provide valuable insights into the dynamic process of dry matter accumulation within various corn hybrids and can serve as a reliable indicator of the optimal harvest time.

Key words: maize, grain filling, yield, Zea mays L.

II-USM-17

PREDSELEKCIONO ISPITIVANJE GENOTIPOVA MAĐARSKE DETELINE

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Vrste roda *Trifolium* ostvaruju simbiotsku vezu sa zemljišnim bakterijama, pripadnicima vrste *Rhizobium leguminosarum bv. trifoli* koja se ogleda u formiranju sitnih kvržica koje su raspoređene po celom korenu. Mađarska detelina (*Trifolium pannonicum* Jacq.) je najmlađi predstavnik roda *Trifolium*, sa potencijalom korišćenja u krmnoj proizvodnji usled niza pozitivnih osobina. Cilj ovog istraživanja bio je ispitivanje potencijala osam genotipova mađarske deteline (deo kolekcije semena Instituta) za simbiozu sa autohtonim sojevima rizobiuma na osnovu broja i morfoloških karakteristika nodula. Eksperiment je postavljen u polukontrolisanim uslovima u vegetacionom prostoru Instituta u jesen 2019. Za potrebe istraživanja korišćeni su sudovi zapremine 8 l koji su bili ispunjeni smešom zemlje sa imanja i peskom u odnosu 3:1. Deset pojedinačnih biljaka svake populacije je koršćeno za dalje istraživanje tako što je po pet biljaka zasađeno u jednu saksiju. Biljke su analizirane naredne godine u fazi punog cvetanja. Na pojedinačnim biljkama su mereni sledeći parametri: dužina i masa korena, masa nadzemnog dela, broj i masa nodula. Vizuelno je uočeno da su nodule uglavnom pojedinačno raspoređene, retko u parovima, većih grupacija nema. Imale su mlečno belu do braon boju; na centralnim žilama razvijeni su parovi krupnih nodula. Prosečan broj nodula izmeren za sve genotipove iznosio je 555,2 dok su se vrednosti kretale u opsegu od minimalnih 120 do maksimalnih 1641. Broj nodula je zavisio i od dimenzija i stepena razvijenosti korena. Činjenica da mađarska detelina ostvaruje simbiotsku zajednicu sa kvržičnim bakterijama čini je dodatno poželjnom vrstom za uzgajanje kao izvor kabaste hrane ali i pozitivnog delovanja na čitav ekosistem.

Ključne reči: Nodulacija,azotofiksacija, *Trifolium pannonicum* Jack., minorne vrste

Zahvalnica: Rad je finansiran od strane Ministarstva nauke, tehnološkog razvoja i inovacija, u skladu sa ugovorom broj: 451-03-47/2023-01/200217.

HUNGARIAN CLOVER GENOTIPES PREBREEDING

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Trifolium species create a symbiosis with soil bacteria, specifically *Rhizobium leguminosarum bv. trifoli*, which results in the formation of tiny nodules that spread throughout the root. Hungarian clover (*Trifolium pannonicum* Jacq.) is the genus's youngest member, having potential for fodder production due to favorable characteristics. The aim of this study was to examine the potential of eight genotypes of Hungarian clover (from the Institute's seed collection) for symbiosis with autochthonous rhizobium strains based on nodule number and morphology. The experiment was set up in the Institute's greenhouse during the autumn of 2019 under partially controlled conditions. For the research, pots with a volume of 8 l were utilized filled with a 3:1 mixture of soil from the farmland and the sand. For analyses, ten plants per genotype were utilized, with five planted in each pot. The following year, during the blooming phase, data was collected. On each plant, the length and mass of the roots, the mass of the aerial part, and the quantity and mass of nodules have been measured. The nodules were observed to be usually individually arranged, seldom in pairs, with no larger clusters. They were milky white to brown in colour, with pairs of huge nodules developing on the central root. The average number of nodules measured across all genotypes was 555.2, with values ranging from a low of 120 to a high of 1641. The number of nodules was also depended by the root's size and stage of development. Because the Hungarian clover forms a symbiotic association with nodule bacteria, it is not only a valuable species for cultivation as a source of animal feed, but it also has a positive impact on the overall environment.

Key words: Nitrogen fixation, nodulation, *Trifolium pannonicum* Jack., minor species

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II-USM-18

POLIMORFIZAM ALELA GLIJADINA I GLUTENINA KOD PŠENICE (*Triticum aestivum* L.)

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Glijadini i glutenini se deponuju u endospermu semena i imaju najveći udeo u sadržaju proteina semena. Cilj ovog rada je identifikacija polimorfizama genskih alela koji kodiraju glijadine i glutenine. U istraživanje je uključeno 10 sorti pšenice. Od svakog genotipa je korišćeno 30 semena za ekstrakciju glijadina sa 70% etanolom, a glutenina sa 10% β-merkaptoetanolom. Glijadini su razdvojeni elektroforezom u rastvoru pufera (pH=3,1) na 8,33% poliakrilamidnom gelu, dok su glutenini razdvajani pomoću SDS-PAGE (pH-8,6) na 11,8% gelu. Elektroforegrami su korišćeni za određivanje alela *Gli-1* i *Gli-2*, kao i alela *Glu-1*. Identifikovano je pet alela (***a, b, c, f, m***) na *Gli-A1*, četiri alela (***b, g, e, l***) na *Gli-B1*, četiri alela (***a, b, g, k***) na *Gli-D1*, pet alela (***b, e, g, m, n***) na *Gli-A2*, šest alela (***b, c, d, g, k, o***) na *Gli-B2* i tri alela (***a, b , e, h, m***) na *Gli-D2* lokusu. Za podjedinice glutenina visoke molekularne mase (HMVGS) je identifikovano tri alela (***a, b, c***) na *Glu-A1*, sedam alela (***a, b, c, d, f, h, i***) na *Glu-B1* i tri alela (***a, c, d***) na *Glu-D1*. Identifikovani aleli na svakom *Gli-1*, *Gli-2* i *Glu-1* lokusu ukazuju na visok polimorfizam proteina glutena i genetičku divergentnost analiziranih genotipova pšenice.

Ključne reči: aleli, glijadini, glutenini, polimorfizam, pšenica.

POLYMORPHISM OF GLIADIN AND GLUTENIN GENE ALLELES IN WHEAT (*Triticum aestivum* L.)

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Gliadin and glutenins are deposited in endosperm of seed and they have the highest share in the protein content of seeds. The aim of this study is identification of gene allele polymorphisms encoding gliadin and glutenins. Ten varieties of wheat were included in this study and 30 seeds from each genotype were used for the extraction of gliadin by 70% ethanole, and glutenins by 10% β-mercaptoethanol. The gliadins were separated by acid PAGE electrophoresis (pH=3.1) on 8.33% polyacrylamide gel, while glutenins were separated by SDS-PAGE (pH-8.6) on 11.8% gel. Electrophoregrams were used for determining *Gli-1* and *Gli-2* alleles as well for Glu-1 allele. The five alleles (***a, b, c, f, m***) at the *Gli-A1*, four alleles (***b, g, e, l***) at the *Gli-B1*, four alleles (***a, b, g, k***) at the *Gli-D1*, five alleles (***b, e, g, m, n***) at the *Gli-A2*, six alleles (***b, c, d, g, k, o***) at the *Gli-B2* and five alleles (***a, b, e, h, m***) at the *Gli-D2* locus were identified. For high molecular weight glutenin subunists (HMWGS) the three alleles (***a, b, c***) at the *Glu-A1*, seven alleles (***a,b, c, d, f, h, i***) at the *Glu-B1* and three alleles (***a c, d***) at the *Glu-D1* were identified. Identified alleles at each *Gli-1, Gli-2* and *Glu-1* loci indicate high polymorphisms of gluten proteins and genetic divergences of analyzed wheat genotypes.

Key words: allele, gliadin, glutenin, polymorphism, wheat

II-USM-19

PROMENE FIZIOLOŠKIH I AGRONOMSKIH OSOBINA STRNIH ŽITA TOKOM POSLEDNJIH 100 GODINA

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Tokom prethodnih 100 godina kod najznačajnijih ratarskih useva u Panonskoj niziji zabeležen je porast prinosa usled unapređenje agronomskih praksi i genetičkog potencijala za prinos. Tokom prošlog veka u Srbiji, prinosi zrna su se povećavali za od 63 kg ha^{-1} kod kukuruza, 45 kg ha^{-1} kod pšenice i 46 kg ha^{-1} kod ječma. Brojna istraživanja ukazala su da je povećanje prinosa zrna kod strnih žita u bliskoj vezi sa rastom broja zrna po jedinici površine. Smanjenje visine biljaka (5 cm dekadno) dovelo je do povećanja žetvenog indeksa, usled veće translokacije suve materije u klas tokom perioda pre cvetanja rezultujući u povećanju broja cvetova po klasu. Tokom poslednjih 100 godina došlo je do značajnih promena u trajanju fenoloških faza kod sorti pšenice i ječma gajenih u Panonskoj niziji. Trajanje perioda od nicanja do cvetanja i perioda od nicanja do fiziološke zrelosti se skratilo, dok se trajanje faze vlatanja kod modernih sorti produžilo. Takođe, druge fiziološke osobine, kao što je efikasnost upotrebe azota su se značajno promenile tokom prošlog veka. Prema tome, unapređenje prinosa strnih žita tokom prošlog veka je rezultat značajnih promena u različitim agronomskim i fiziološkim osobinama. Dalje unapređenje prinosa bi trebalo da se bazira na skraćenju trajanja faze do cvetanja, smanjenju visine biljaka, povećanju broja zrna po jedinici površine i održavanju visokih vrednosti žetvenog indeksa.

Ključne reči: napredak u oplemenjivanju, Panonska nizija, strna žita, unapređenje prinosa

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CHANGES IN PHYSIOLOGICAL AND AGRONOMICAL TRAITS IN SMALL GRAIN CEREALS OVER THE PAST 100 YEARS

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Cereal crops have shown a steady and successive increase in grain yield in the southern Pannonian environment, owing to changes in agronomy and grain yield potential. Over the past century in Serbia, grain yield has increased at a rate of 63 kg ha^{-1} in maize, 46 kg ha^{-1} in wheat and 46 kg ha^{-1} in barley. Various studies exploring the agronomical basis of grain yield progress in major cereal crops have indicated that the number of grains per unit area is one of the main traits associated with grain yield improvement. A decrease in plant height (5 cm per decade) has led to a decline in straw yield and an increase in the harvest index, favoring better partitioning of dry matter during pre-anthesis development, ultimately resulting in improved grain yield in wheat and barley. Significant changes have also occurred in the duration of different phenological stages in wheat and barley cultivars under the conditions of the Pannonian plain. Notably, the duration of the emergence-anthesis and emergence-physiological maturity phases has decreased during the past century, while the duration of the stem elongation-anthesis phase has become longer in modern cultivars. Additionally, other physiological traits such as nitrogen use efficiency have been significantly altered over the same period. In conclusion, the breeding progress observed in small grain cultivars during the past century is a result of significant changes in various agronomical and physiological traits. For future improvements in small grain yield, the focus should be on increasing both the grain number per spike and grain weight, while maintaining high values of the harvest index.

Key words: breeding progress, Pannonian plain, small grain, yield improvement

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MOLEKULARNA IDENTIFIKACIJA VRSTE *FUSARIUM VERTICILLIOIDES* PATOGENA ZRNA STRNIH ŽITA

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Gljive roda *Fusarium* spadaju u grupu ekonomski značajnih prouzrokovača fuzarioze klasa strnih žita. Vrsta *Fusarium verticillioides* je kosmopolitski rasprostranjena, ekonomski značajna i toksigena vrsta. Primarni domaćin ove vrste je kukuruz, ali je njeno prisustvo zabeleženo i na pšenici, durum pšenici i ječmu. Za potrebe izolacije DNK zasejano je 36 izolata *Fusarium* spp. koji su gajeni na KDA podlozi, 7 dana u termostatu pri temperaturi od 25°C.Molekularna identifikacija i karakterizacija izvršena je primenom prajmera specifičnih za vrstu *F. verticillioides*. Specifični prajmeri koji su korišćeni za identifikaciju su VER1/VER2, zasnovani na genu za kalmodulin, i FV-F2/FV-FR, zasnovani na *gaoB* genu. Odabranih 14 izolata je okarakterisano na osnovu tri regiona: ITS regiona primenom prajmera ITS1 i ITS4. ITS region je univerzalni region za identifikaciju gljiva. Zatim, izolati su okarakterisani i na osnovu delu gena za elongacioni faktor (TEF 1-α regiona) pomoću prajmera EF1/EF2. TEF 1-α region je primarni region za identifikaciju vrste *F. verticillioides*. Takođe identifikacija je izvršena i na osnovu delu gena za RNK polimerazu (RPB2) primenom 7cf/11ar prajmera. RPB2 region je sekundarni barkod marker za identifikaciju vrste *F. verticillioides*. Sekvenciranjem tri regiona dobijene su sekvence na osnovu kojih su rekonstruisana filogenetska stabla za svaki region posebno. Od 36 izolata, kod 14 izolata dobijeni su amplikoni očekivanih veličina sa prajmerima VER1/VER2 i FV-F2/FV-R. Identifikacija ovih izolata potvrđena je i na osnovu sva tri regiona (ITS, TEF1-α i RPB2).

Ključne reči: *F. verticillioides*, ITS, TEF 1-α, RPB2

Zahvalnica: Ovo istraživanje finansirano je od strane Ministarstva nauke, tehnološkog razvoja i inovacija Republike Srbije (broj ugovora: 451-03-47/2023-01/200040).

MOLECULAR IDENTIFICATION OF *FUSARIUM VERTICILLIOIDES* PATHOGEN OF SMALL GRAIN KERNELS

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Fungi of the genus *Fusarium* belong to the group of economically important species that cause fusariosis on small grain cereals. The species *Fusarium verticillioides* is a cosmopolitan, economically important and toxigenic species. The primary host of this species is maize, but its presence has also been detected on wheat, durum wheat and barley. For the purposes of DNA isolation, 36 isolates of *Fusarium* spp. were grown on PDA medium, for 7 days in a thermostat at a temperature of 25°C. Molecular identification and characterization was performed using primers specific for the species *F. verticillioides*. The specific primers used for identification were VER1/VER2, based on the calmodulin gene, and FV-F2/FV-FR, based on the *gaoB* gene. The selected 14 isolates were characterized based on three regions: ITS region using primers ITS1 and ITS4. The ITS region is a universal region for fungal identification. Then, the isolates were characterized based on part of the elongation factor gene (TEF 1-α region) using EF1/EF2 primers. The TEF 1-α region is the primary region for identification *F. verticillioides*. Identification was also performed based on part of the gene for RNA polymerase (RPB2) using the 7cf/11ar primer. The RPB2 region is a secondary barcode marker for species identification of *F. verticillioides*. By sequencing three regions, sequences were obtained on the basis of which phylogenetic trees were reconstructed for each region separately. Out of 36 isolates, 14 isolates obtained amplicons of expected sizes with primers VER1/VER2 and FV-F2/FV-R. The identification of these isolates was confirmed based on all three regions (ITS, TEF1-α and RPB2).

Key words: *F. verticillioides*, ITS, TEF 1-α, RPB2

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UVIDI U NASLEDNE MEHANIZME OTPORNOSTI SUNCOKRETA NA UGLJENASTU TRULEŽ: GENETSKI FAKTORI

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Ugljenasta trulež prouzrokovana gljivom *Macrophomina phaseolina* (Tassi) Goid, predstavlja jednu od ekonomski značajnih bolesti suncokreta u svetu, posebno u suvim i toplim klimatskim regionima. Ovo istraživanje imalo je za cilj ispitivanje mehanizama nasleđivanja otpornosti na *M. phaseolina* analizom dve populacije suncokreta. Obe populacije su formirane ukrštanjem otpornih i osetljivih inbred linija. Osetljiva inbred linija, AB OR8, bila je zajednička za obe populacije, dok je otporni roditelj u prvoj populaciji bila inbred linija PB 21, a u drugoj populaciji inbred linija VL A8. Prva populacija obuhvatala je 200 genotipova, a druga populacija 190. Genotipovi su klasifikovani u četiri grupe prema nivou otpornosti, a odnos ovih grupa je upoređen sa teorijskim očekivanim odnosima. Ispitivani odnosi uključivali su dominantnu epistazu (12:3:1), recesivnu epistazu (9:3:4), potpunu dominaciju (9:3:3:1), potpunu dominaciju sa recesivnom epistazom (9:4:3), dvostruko recesivnu epistazu (9:7), dvostruke interakcije sa kumulativnim efektima (9:6:1), dvostruka dominantna epistaza (15:1) i kombinacije dominantne i recesivne epistaze (13:3). Kroz uporednu analizu eksperimentalnih i teorijskih podataka zaključeno je da otpornost suncokreta na *M. phaseolina* ne sledi navedene nasledne mehanizme. Posledično, može se zaključiti da nasledna osnova otpornosti suncokreta na ovaj patogen uključuje više gena sa minor efektima. S obzirom na poligenu prirodu svojstva otpornosti, važno je sprovesti dalja istraživanja kako bi se utvrdili i razumeli svi efekti koji utiču na otpornost suncokreta na *M. phaseolina*.

Ključne reči: geni, mikoze, F2 populacija, inbred linija

Zahvalnica: Rad je podržalo Ministarstvo nauke, tehnološkog razvoja i inovacija Republike Srbije, ugovor broj 451-03-47/2023-01/200032, Fond za nauku Republike Srbije, program IDEJE, "SmartSun", br. 7732457, Evropska komisija kroz projekat Twining zapadnog Balkana "CROPINNO", br. 101059784, Centar izuzetnih vrednosti za inovacije u oplemenjivanju biljaka tolerantnih na promene klime - Climate Crops, Institut za ratarstvo i povrtarstvo, Novi Sad, Srbija.

INSIGHTS INTO THE INHERITANCE MECHANISMS OF SUNFLOWER RESISTANCE TO CHARCOAL ROT: UNRAVELING THE GENETIC FACTORS

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Charcoal rot, caused by soil-borne fungus *Macrophomina phaseolina* (Tassi) Goid, stands out as a significant sunflower disease globally, particularly in arid and warm climatic regions, with notable economic implications. This study aimed to examine the inheritance mechanisms of resistance to *M. phaseolina* by investigating two sunflower populations. In this experiment, the progeny populations of F2 plants were examined. Both populations were formed through the strategic crossing of resistant and susceptible inbred lines. The susceptible inbred line AB OR 8, was common to both populations, while the resistant parent in the first population was inbred line PB 21, and in the second population inbred line VL A 8. The first population included 200 genotypes, and the second 190. Genotypes were classified in four groups according to resistance level and ratio of these groups was compared with theoretical expectations of progeny ratio. The experimental ratios included dominant epistasis (12:3:1), recessive epistasis (9:3:4), complete dominance (9:3:3:1), complete dominance with recessive epistasis (9:4:3), duplicate recessive epistasis (9:7), duplicate interactions with cumulative effects (9:6:1), duplicate dominant epistasis (15:1), and combinations of dominant and recessive epistasis (13:3). Through comparative analysis of experimental and theoretical data, it was deduced that the inheritance of sunflower resistance to *M. phaseolina* did not correspond to any of the experimental ratios outlined above. Consequently, it was concluded that the inheritance basis of sunflower resistance to this fungus involves multiple genes with minor effects. Given the polygenic nature of the resistance trait, it is important to conduct further research to pinpoint and understand all the effects governing sunflower resistance to *M. phaseolina.*

Key words: genes, fungus, F2 populations, inbred line

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FENOTIPIZACIJA KORENA SUNCOKRETA NA TOLERANTNOST PREMA SUŠI

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Suncokret (*Helianthus annuus* L.), u poređenju sa drugim usevima se smatra bolje adaptiranim prema sušnim uslovima. Međutim, različito ispoljavanje suše može prouzrokovati štete merljive u prinosu semena i sadržaju ulja u semenu. U poljskim uslovima stres izazvan sušom se ispoljava u vidu uvelosti počev od donjih spratova lišća koja napreduje sa trajanjem sušnih uslova. Razlike u stepenu uvelosti između biljaka suncokreta i genotipova su, iako lako uočljive, nedovoljne za pouzdan zaključak o tolerantnosti prema suši. Za potrebe kvantifikacije tolerantnosti suncokreta prema suši i uticaja suše na arhitekturu korena razvijene su različite metode od kojih jedna podrazumeva gajenje biljaka u rizotronima tokom vremenskog perioda ograničenog brzinom rasta korena. Cilj ovog istraživanja je bilo proučavanje korena suncokreta primenom rizotrona u uslovima suše. U okviru metodoloških ograničenja, rizotroni su omogućili proučavanje arhitekture korena putem merenja niza osobina, kao i ponovljena merenja tokom eksperimenta uz manje oštećenje korenovog sistema nakon odvajanja od supstrata u kom biljka raste. Međutim, ekperimenti u rizotronima su ograničeni u trajanju i podaci se prikupljaju sa biljaka u početnim fazama rasta. Ograničenje na početne faze rasta čini neophodnim, ukoliko je moguće, komplementarna merenja u kasnijim fazama rasta i razvića suncokreta ili određivanje osobina koje bi bile informativne o reakciji suncokreta prema suši u kasnijim fazama rasta. Rezultati ovog istraživanja predstavljaju dalji napredak u fenotipizaciji korena u širem okviru oplemenjivanja suncokreta prema suši.

Ključne reči: suncokret, fenotipizacija korena, arhitektura korena, tolerantnost prema suši

Zahvalnica: Ovo istraživanje je omogućeno podrškom Fonda za nauku Republike Srbije, putem projekta programa "Creating climate smart sunflower for future challenges" (SMARTSUN) broj 7732457, Evropske komisije kroz program "Twinning Western Balkans" projekat broj 101059784 (CROPINNO) i Centra izuzetnih vrednosti za inovacije u oplemenjivanju biljaka tolerantnih na promene klime - Climate Crops, Institut za ratarstvo i povrtarstvo, Novi Sad, Srbija.

SUNFLOWER ROOT PHENOTYPING FOR DROUGHT TOLERANCE

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Sunflower (*Helianthus annuus* L.), compared to other crops is considered to be better adapted to drought conditions. However, various drought scenarios can inflict damage quantified in terms of lower seed yield and oil content. In field conditions drought stress in visible in wilting starting with leaves of lower strata and progressing with persistence of stress conditions. Differences in level of wilting symptoms between sunflower plants and genotypes can be observed, although firm conclusion about drought tolerance is not easy to make. To quantify drought tolerance and impact of drought on root architecture various approaches in root phenotyping have been developed. One of methods includes growing plants in rhizotrons for period of time limited by root growth speed. The goal of this research was study of sunflower root system in rhizotrons and in drought conditions. Within its limitations rhizotrons offered advances in studding root architecture in number of traits that can be quantified, possibility for continuous measurements over a experimental period and less damage inflicted to roots after separation of root from substrate. However, the root growth experiments in rhizotrons were limited in time and data were gathered from initial plant growth period. This makes necessary for complementary observations of drought stress in later growth stages, if possible. Another approach would include finding trait or group of traits that can be informative of plant response to drought in later period of growth and development. Results of this research present a progress in root phenotyping in broader field of sunflower breeding to drought stress.

Key words: sunflower, root phenotyping, root architecture, drought tolerance

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II-USM-23

UTICAJ VODNOG DEFICITA NA ANATOMSKE OSOBINE KORENA SUNCOKRETA

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Kapacitet biljke da preživi u uslovima suše u tesnoj vezi je sa osobinama korena. Većina naučnih radova koji se bave tolerancijom na sušu usmerena je na genetičke i molekularne analize. Međutim, osim na morfologiju korena (dubinu, pravac rasta i grananje), suša utiče i na anatomske karakteristike korena. U cilju odabira genotipova suncokreta tolerantnih na sušu, analizirana su tri genotipa uzgajana četrnaest dana u rizotronima, pri dva različita tretmana vlažnosti (70% - kontrola i 42% - suša). Metodom kriotehnike pravljeni su poprečni preseci korena, u nekoliko nivoa, duž celog korena. Preliminarni rezultatati pokazali su, da kod sva tri genotipa u uslovima vlaznosti od 42%, dolazi do smanjenja površine poprečnog preseka korena, površine ćelija korteksa (egzodermisa i mezodermisa), procentualnog udela centralnog cilindra i ksilema, kao i površine lumena trahejarnih elementa. Dobijene genotipske razlike u anatomskim karakteristikama korena, kao odgovor na vodni deficit, mogu biti značajne smernice u izboru genotipova suncokreta sa većim brojem kseromorfnih karakteristika.

Ključne reči: koren, anatomija, suša

Zahvalnica: Ovaj rad je podržan od strane Ministarstva obrazovanja, nauke i tehnološkog razvoja Republike Srbije, broj 451-03-68/2022-14/200032, Fonda za nauku Republike Srbije, kroz projekat IDEJE „Stvaranje klimatski pametnog suncokreta za buduće izazove“ (SMARTSUN) broj 7732457, Centra izuzetnih vrednosti za inovacije u oplemenjivanju biljaka tolerantnih na promene klime – CLIMATE CROPS, Instituta za ratarstvo i povrtarstvo iz Novog Sada, i od strane Evropske komisije kroz Twinning projekat Zapadnog Balkana CROPINNO, broj 101059784.

SUNFLOWER ROOT ANATOMICAL TRAITS IN RESPONSE TO WATER DEFICIT

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A plant's capacity to survive in drought condition is in close relation with the root traits. Most of the scientific work related to drought tolerance is focused towards genetic and molecular analysis. Apart from the root morphology (depth, orientation and branching), drought condition reflects the root anatomical characteristics. In order to select sunflower genotypes tolerant to drought, we analyzed the three genotypes grown for fourteen days in rhizotrons, under two different humidity treatments (70% as control and 42% as drought). Root cross-sections were cut along root maturity using a cryotechnique. Our preliminary results showed that characters such as: root cross section area, cortical cells size (exodermis and mesodermis), central cylinder and xylem percentage, and lumen tracheary elements were reduced under 42% humidity, in all three genotypes. Differences in the root response to water deficit among genotypes, especially with the xylem architecture (structure), can be significant guidelines in the selection of sunflower genotypes with higher xeromorphic traits.

Key words: root, anatomy, drought.

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II-USM-24

PRIZNAVANJE SORTI POLJOPRIVREDNOG BILJA U REPUBLICI SRBIJI – ANALIZA I TRENDOVI

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Zakon o priznavanju sorti poljoprivrednog bilja (Sl. Glasnik broj 30/10) reguliše proces priznavanja, upisa i održavanja sorti poljoprivrednog bilja u Republici Srbiji. Priznavanje sorti obuhvata kako domaće nove sorte, tako i uvođenje stranih sorti u proizvodnju. Da bi se sorta poljoprivrednog bilja priznala, moraju se zadovoljiti određeni uslovi. Sorta mora biti različita (D), uniformna (U) i stabilna (S), što se često skraćeno označava kao DUS test. Osim toga, sorta treba da ima bolju proizvodnu i upotrebnu vrednost (VCU) i ime sorte mora biti u skladu sa propisanim zahtevima. Registar sorti poljoprivrednog bilja se sastoji iz dva dela - registra priznatih sorti i registra brisanih sorti. Ovaj registar sadrži informacije o priznatim domaćim i stranim sortama različitih biljnih vrsta, uključujući ratarske i povrtarske biljke, voće i vinovu lozu. Takođe, registar obuhvata informacije o odomaćenim sortama, odnosno sortama koje su se uspešno prilagodile uslovima u Srbiji. Prema podacima od 14.08.2023. godine, u Registru sorti nalazi se ukupno 5575 priznatih sorti i 1049 brisanih sorti. Od ukupnog broja priznatih sorti, 1098 sorti su odomaćene, 3129 su domaće sorte, a 3129 su strane sorte. Ovi statistički podaci pružaju uvid u raznolikost i obim različitih sorti koje su priznate u Srbiji.

Ključne reči: priznavanje sorti, Zakon o priznavanju sorti, sorte poljoprivrednog bilja, Registar sorti, statistika

REGISTRATION OF AGRICULTURAL PLANT VARIETIES IN THE REPUBLIC OF SERBIA – ANALYSIS AND TRENDS

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The Law on The Registration of Agricultural Plant Varieties (Official Gazette No. 30/10) regulates the process of registration and maintenance of agricultural plant varieties in the Republic of Serbia. Registration of varieties encompasses both new domestic varieties and the introduction of foreign varieties into production. In order for an agricultural plant variety to be registered, specific conditions must be met. The variety must be distinct (D), uniform (U), and stable (S), often abbreviated as the DUS test. Additionally, the variety should exhibit improved production and utility value (VCU), and the variety's name must comply with prescribed requirements. The Registry of Agricultural Plant Varieties consists of two parts - the registry of registered varieties and the registry of deleted varieties. This registry contains information about recognized domestic and foreign varieties of various plant species, including crops, vegetables, fruits, and grapevines. Furthermore, the registry includes information about acclimatized varieties, which are varieties that have successfully adapted to conditions in Serbia. As of August 14, 2023, the Registry of Varieties contains a total of 5575 recognized varieties and 1049 deleted varieties. Out of the total number of registered varieties, 1098 varieties are domesticated, 3129 are domestic varieties, and 3129 are foreign varieties. These statistical data provide insights into the diversity and extent of different varieties registered in Serbia.

Key words: Registration of varieties, law on Registration of varieties, varieties of agricultural plants, registry of varieties, statistics

II-POS-25

VARIJABILNOST PRINOSA USEVA POD UTICAJEM KLIMATSKIH ČINILACA

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U radu je primenom metoda deskriptivne statistike i analize varijanseistraživan uticaj temperature vazduha i sume padavina na varijabilnost prinosa ekonomski najznačajnijih useva u tridesetogodišnjem periodu (1991 – 2021.godine). Korišćeni su podaci o prosečnim prinosima kukuruza, pšenice, soje, suncokreta i šećerne repe dobijeni na oglednom polju Istraživačko-razvojnog instituta Tamiš u posmatranom periodu. Tokom trideset godina, prosečna godišnja temperatura vazduha kretala se od 10,6°Cdo 14,1°Cu 1993. odnosno 2000. godini. Najmanja suma padavina zabeležena je 2000. godine i iznosila je 334 mm, a najveća 2014. godine kada je zabeležena godišnja suma padavina od 973,70 mm. Analiza varijabiliteta prinosa ukazuje da je najveći koeficijent varijacije prinosa zabeležen kod soje (34,25%), zatim šećerne repe (30,8%) i kukuruza (30,5%), dok su manje vrednosti dobijene kod suncokreta (22.3%) i pšenice (20%). Prosečan prinos soje kretao se u nivou od 954 kg do 4.631 kg (1993. i 2018. godine),šećerne repe od 18.270 kg do 78.900 kg(1993.i 2010. godine), kukuruza od2.887 kg do 11.523 kg (2000. i 2006. godine),prinos suncokreta od 1.333 kg do 3.734 kg (1999. i 2013. godine), a prinos pšenice u nivou 3.590 kg do 7.957 kg (2006. i 2021. godine). Rezultati analize varijanse i lineare regresije za tridesetogodišnji period pokazuju da su padavine imale značajan ($p < 0,05$) uticaj na prinos kukuruza ($\hat{y}i=8630,7+4,924*xi$) i soje ($\hat{y}i=2212,9+2,273*xi$), dok na prinos pšenice, suncokreta i šećerne repe nije utvrđen značajan uticaj klimatskih činilaca u posmatranom periodu. Međutim, kada se izvrši detaljnija analiza po dekadama, zapaža se da je prinos kukuruza ($\hat{y}i=2516,4 +7,917 *xi$), soje ($\hat{y}i=-957,710+4,124 *xi$) i šećerne repe ($\hat{y}i=-35680,135+43,110*xi$) u prvoj dekadi značajno zavisio od sume padavina. Sa druge strane, u drugoj dekadi temperatura jeznačajno uticala na visinu prinosa kukuruza ($\hat{y}i=37077,474 -0,093*xi$) i soje ($\hat{y}i=11921,39–8,452 *xi$), dok u trećoj dekadi analizirani klimatski činioci nisu značajno uticali na varijabilnost prinosaposmatranih useva. Dobijeni rezultatukazuje daklimatski činioci najviše pogađaju prinos kukuruza, ali i da na variranje prinosa useva utiču i drugi faktori, verovatno gajenje adaptibilnih genotipova i primena adekvatnih agrotehničkih mera.

Ključne reči: variranje prinosa, pšenica, kukuruz, suncokret, soja, šećerna repa

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VARIABILITY OF CROP YIELD UNDER THE INFLUENCE OF CLIMATE FACTORS

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The study examined the impact of air temperature and the sum of precipitation on the yield variability of the most commercially important crops over a thirty-year period (1991–2021) using methods of descriptive statistics and analysis of variance. The data on the average yields of corn, wheat, soybean, sunflower, and sugar beet obtained on the experimental field of the Tamiš Research and Development Institute in the observed period were used. The average annual air temperature for a period of 30 years varied between 10.6°C and 14.1°C in 1993 and 2000, respectively. The lowest sum of precipitation, 334 mm, was recorded in 2000, and the highest amount, 973.70 mm, was recorded in 2014. The analysis of yield variability indicates that soybean had the highest coefficient of variation (34.25%), followed by sugar beet (30.8%) and corn (30.5%), while sunflower (22.3%) and wheat (20%) had lower values. The average yield of soybean ranged from 954 kg to 4,631 kg (1993 and 2018), sugar beet from 18,270 kg to 78,900 kg (1993 and 2010), corn from 2,887 kg to 11,523 kg (2000 and 2006), sunflower from 1,333 kg to 3,734 kg (in 1999 and 2013), and the wheat yield at the level of 3,590 kg to 7,957 kg (2006 and 2021). The results of the analysis of variance and linear regression analysis for the thirty-year period reveal that precipitation had a significant ($p < 0.05$) influence on the yield of corn ($\hat{y}i=8630.7+4.924*xi$) and soybean ($\hat{y}i=2212.9+2.273*xi$), while no significant influence of climatic factors was found on the yield of wheat, sunflower, and sugar beet during this period. However, when a more detailed analysis is performed by decade, it is noted that the sum of precipitation had a significant impact on the corn ($\hat{y}i= 2516.4 + 7.917 *xi$), soybean ($\hat{y}i= -957.710 + 4.124 *xi$), and sugar beet ($\hat{y}i= -35680.135 + 43.110*xi$) yields in the first decade. On the other hand, in the second decade, temperature significantly influenced the yield of corn ($\hat{y}i= 37077.474 -0.093*xi$) and soybean ($\hat{y}i= 11921.39 - 8.452*xi$), while in the third decade, the analysed climate factors did not significantly influence the variability of the observed crop yields.The obtained result indicates that climatic factors affect the yield of corn the most, but also that other factors influence the variation in crop yield, probably the cultivation of adaptable genotypes and the application of adequate cultural practice.

Key words: yield variation, wheat, corn, sunflower, soybean, sugar beet

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II-POS-26

PRINOS I PARAMETRI KVALITETA ZRNA ELITNIH HIBRIDA KUKURUZA, DIVERZITET I MULTIKOLINEARNOST ISPITIVANIH OSOBINA

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Genetska konstitucija, uslovi gajenja, uključujući agrotehniku i manipulaciju posle žetve, utiču na kvalitet zrna kukuruza. Zahtevi za kvalitet se razlikuju od jedne do druge upotrebe i uvek moraju biti definisani u skladu sa metodama koje se primenjuju u preradi i korišćenju. Ciljevi ovog istraživanja bili su da se : i) procene prinos, komponente prinosa i kvaliteta zrna šest elitnih hibrida kukuruza, ispitivanih tokom 5 godina u mikro i makro ogledima; ii) utvrde međusobni odnosi ispitivanih osobina u zavisnosti od efekta hibrida, godine i roditeljskih komponti. Efekat godine je u velikoj meri uticao na varijaciju svih ispitivanih parametara, efekat oca nije bio statistički značajan za komponente prinosa, dok su efekti i oca i majke bili značajni za većinu ispitivanih osobina kvaliteta. PCA analiza je ukazala na značajan uticaj genetske konstitucije hibrida na fizičke parametre i strukturu zrna. Hibridi oca LM3 imali su veću apsolutnu masu, udeo mekog endosperma i otpornost na mlevenje, a niži indeks apsorpcije vode i udeo perikarpa. Hibridi majke LF2 su imali veći udeo endosperma, dok su hibridi majke LF1 imali veći udeo klice i ulja u zrnu. Rezultati su ukazali da je moguće simultano oplemenjivanje na povećanje skroba i proteina (uz povećanje prinosa), kao i oplemenjivanje na povećanje sadržaja proteina i ulja (uz smanjenje prinosa). Istovremeno oplemenjivanje u pravcu povećanja sadržaja skroba i ulja bilo bi otežano višestrukim negativnim odnosima ove dve osobine. Međutim, iako su utvrđene statistički značajne razlike u parametrima kvaliteta, one nisu napravile kvalitativnu razliku u proizvodnim ogledima. Zbog toga je potrebno formirati posebne programe oplemenjivanja za različite namene.

Ključne reči: komponente prinosa i kvaliteta zrna,multivarijacioni pristup, *Zea mays* L.

Zahvalnica: Rad je rezultat istraživanja u okviru ugovora 451-03-47/2023-01/200040 od 17.01.2023. godine, finansiranog od strane Ministarstva nauke, tehnološkog razvoja i inovacija Republike Srbije.

GRAIN YIELD AND GRAIN QUALITY OF ELITE MAIZE HYBRIDS, DIVERSITY AND MULTICOLLINEARITY OF EVALUATED TRAITS

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Genetic background, environmental conditions, agricultural practices and post-harvesting influence maize grain quality. The quality requirements differ from one use to another, and need to be defined in accordance with the methods applied in processing and utilisation. The objectives of this research were: i) to evaluate yield and grain quality traits of six elite maize hybrids, tested during 5-year micro and macro trials; ii) to determine the evaluated traits relationshipaccording to hybrid-, year- and parental components-dependence pattern. The year effect greatly influenced the variation of all examined parameters, the male effect was not significant for yield components, while the effects of both, male and female parent were significant for most of the examined quality traits. PC analysis indicated a significant effect of the hybrid's genetic composition on physical parameters and kernel structure. Hybrids of male LM3 had higher 1000 kernelweight, portion of soft endosperm and resistance to grinding, and lower water absorption index and pericarp portion. Hybrids of female LF2 had a higher portion of endosperm, while hybrids of female LF1 had higher portion of germ and oil in the grain. Accordingly, simultaneous breeding for increased starch and protein resulted in yield increase, forincrease protein and oil content in yield reduction, while simultaneous breeding for increased starch and oil content is hampered by multiple negative relationships. Although significant differences in quality parameters were determined, they did not make a qualitative difference in production trials. Therefore, it is necessary to form special breeding programmes for different purposes.

Key words:*Zea mays* L., grain yield and quality traits, multivariate approach

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II-POS-27

EFEKAT ČIŠĆENJA PODATATKA NA REZULTATE STATISTIČKE OBRADE PODATATKA ANALIZOM VARIJANSE

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S obzirom na postojanje interakcije između genotipa i spoljašnje sredine, ispitivanje performansi prinosa zrna novostvorenih genotipova kukuruza vrši se na nekoliko lokacija i/ili godina u ogledima sa manjim oglednim parcelama (MESPT). Ovo bi trebalo da obezbedi izbor najboljih genotipova, što je od kritične važnosti za proces oplemenjivanja. Nivo i stabilnost prinosa zrna su najvažnije karakteristike kada je u pitanju oplemenjivanje kukuruza u okviru odgovarajućih grupa zrenja. Vema je važno izabrati eksperimentalne lokacije, sa ciljem da se pokrije raspon zemljišno-klimatskih uslova ciljnog uzgojnog područja. Kako se tokom eksperimenata ne mogu kontrolisati ni zemljišni ni klimatski faktori, kao i zbog niza drugih okolnosti, podaci koje dobijamo u ovim eksperimentima nisu uvek savršeni. U tom smislu, pre obrade podataka podatke je potrebno pažljivo analizirati i po potrebi, onda kada se proceni da evidentno ne predstavljaju performanse genotipova na koje se odnose, u manjoj ili većoj meri korigovati (čišćenje podataka). U tom smislu, postoji nekoliko načina korekcije nereprezentativnih podataka, a razvijeni algoritami treba da obezbede objektivnu procenu performansi ispitivanih genotipova. Postoje mnoge definicije kvaliteta podataka, ali podaci se generalno smatraju visoko kvalitetnim ako su pogodni za predviđenu upotrebu, donošenje pouzdanih odluka i planiranje. Glavni cilj ovog rada je da se istakne značaj procesa čišćenja podataka u MESPT-u, procena njegovog uticaja na rezultate statističke obrade dobijene pomoću ANOVA (najčešće korišćeni statistički alat od strane oplemenjivača kukuruza) kao i potencijalnih efekata na odluke o unapređenju hibrida kukuruza koje se donose na osnovu rezultat ANOVA.

Ključne reči: oplemenjivanje, hibrid kukuruza, višelokacijski ogledi, prinos zrna, stabilnost prinosa

THE EFFECT OF DATA CLEANING ON THE RESULTS OF STATISTICAL DATA PROCESSING BY ANALYSIS OF VARIANCE

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Considering the existence of genotype × environment interaction, grain yield performance testing of newly created maize genotypes is performed in several locations and/or years in trials with smaller experimental plots (MESPT). This should ensure the selection of the best genotypes, which is of critical importance for the breeding process. Certainly, the level of grain yield and yield stability are the most important features when it comes to breeding corn within the framework of the appropriate maturation groups. It is important to choose the locations where the experiments will be carried out, with the aim of covering the range of soil and climatic conditions of the target cultivation area. As it is about conducting experiments where neither soil nor climatic factors can be controlled, and due to a number of other circumstances, the data we get in these experiments are not always perfect. In this sense, before processing the data obtained from the experiment, it is necessary to carefully analyze them and, if necessary, correct a smaller or larger number of data that evidently do not represent the performance of the genotypes to which they refer (data cleaning). There are several ways of correcting non-representative data and developed algorithms that should provide an objective assessment of the performance of the examined genotypes. *There are many definitions of data quality but data is generally considered high quality if it is fit for intended uses in operations, decision making and planning.* Main aim of this paper is to underline importance of data cleaning process in MESPT, assessment of its effects on statistical processing results obtained by ANOVA (most frequently used statistical tool by maize breeders), as well as potential effects on maize hybrids advancement decisions made based on ANOVA results.

Key words: breeding, maize hybrids, multi environment trials, grain yield, yield stability

II-POS-28

OPLEMENJIVANJE KUKURUZA UZ POMOĆ METODE DUPLICIRANIH HAPLOIDA U INSTITUTU ZA KUKURUZ "ZEMUN POLJE"

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In vivo metoda dupliciranih haploida u Institutu za kukuruz „Zemun Polje" koristi se u oplemenjivanju kukuruza od 2014. godine. Pristup omogućava dobijanje potpuno homozigotnih inbred linija tzv. duplohaploidnih (DH) linija za samo dve godine (dve do tri generacije), za razliku od konvencionalnog oplemenjivanja gde je potrebno bar sedam do osam generacija kako bi se postigla neophodna homozigotnost. Metoda se sastoji iz nekoliko koraka: 1) indukcija haploida iz odabranih populacija ukrštanjem sa linijom induktorom haploida (prva godina/letnja generacija); 2) selekcija haploidnih zrna (prva godina/letnja generacija); 3) duplikacija hromozoma (druga godina/zimska generacija) i 4) umnožavanje dobijenih DH linija (druga godina/letnja generacija). Do sada je dobijeno oko 13000 DH linija iz oko 350 populacija koje pripadaju različitim heterotičnim grupama. U okviru programa sprovode se i aktivnosti sa ciljem razvoja novih induktora haploida sa povišenim procentom indukcije haploida i poboljšanim agronomskim svojstvima. Osam induktora-kandidata je specifičnom procesom selekcije odabrano i u 2023. godini ocenjeno u mini ogledu sa komercijalno dostupnim induktorima, a mereni su visina biljke, produkcija polena, ozrnjenost u ukrštanju, kao i procenat indukcije haploida. U okviru rada na optimizaciji metode, ispitivan je iuticaj populacije (heterotične grupe) i spoljašnje sredine na uspešnost metode. Utvrđen je značajan uticaj spoljašnjih uslova, kao i heterotične grupe odnosno genotipa na indukciju i duplikaciju, kao i konačnu uspešnost metode. Prvi hibridi sa DH linijom kao roditeljskom komponentom već su registrovani od strane Sortne komisije Republike Srbije za komercijalno gajenje u Srbiji.

Ključne reči: dupliciranih haploidi, kukuruz, oplemenjivanje

Zahvalnica: Istraživanje u potpunosti je finansirano od strane Instituta za kukuruz „Zemun Polje"

MAIZE BREEDING USING DOUBLED HAPLOID METHOD AT THE MAIZE RESEARCH INSTITUTE "ZEMUN POLJE"

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In vivo double haploid method has been used in maize breeding at the Maize Research Institute „Zemun Polje" since 2014. The approach allows the development of completely homozygous inbred lines, so-called doubled haploid (DH) lines, in just two years (two to three generations), unlike conventional breeding where at least seven to eight generations are needed to achieve necessary homozygosity. The method consists of several steps: 1) haploid induction from selected populations by crossing with a haploid inducer line (first year/summer generation); 2) selection of haploid kernels (first year/summer generation); 3) chromosome duplication (second year/winter generation) and 4) multiplication of the obtained DH lines (second year/summer generation). So far, about 13,000 DH lines have been obtained from about 350 populations belonging to different heterotic groups. Activities aimed at developing new haploid inducers with an increased haploid induction rate and improved agronomic properties are carried out within the program. Eight candidate inducers were selected through a specific selection process and in 2023 were evaluated in mini-trial with commercially available inducers, where plant height, pollen production, cross kernel set, and the haploid induction rate were measured. As part of the optimization of the method, the influence of the population (heterotic group) and the environment on the method success was also examined. A significant influence of environment, as well as heterotic group, that is, genotype, on the induction and duplication, as well as the overall method success was determined. The first hybrids with the DH line as a parental component have already been registered by the Variety Commission of the Republic of Serbia for commercial growing in Serbia.

Key words: breeding, doubled haploids, maize

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II-POS-29

ANALIZA NIVOA EKSPRESIJE GENA (iRNK) U RANIM FAZAMA RAZVIĆA KUKURUZA U USLOVIMA STRESA NISKIM TEMPERATURAMA

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Dve inbred linije različite osetljivosti na niske temperature – L1 (osetljiva) i L2 (tolerantna) gajene su u optimalnim uslovima do V3 faze rasta. Obe linije su u naznačenoj fazi rasta tretirane niskim temperaturama (10/8° C; fotoperiod: 12/12h; intenzitet svetla: 700 μmol/m2/s) u trajanju od 6 i 24 sati. Posle završenog tretmana, uzeti su uzorci korena i listova tretiranih biljaka za obe ispitivane tačke. Nakon sekvenciranja sintetisanih cDNK biblioteka (engl. *paired-end 150 sequencing Illumina® Novaseq 6000*), urađena je analiza diferencijalne ekspresije gena (DEG) između dva stanja/grupe pomoću DESeq2 R paketa (R software). Identifikacijom DEG između lista i korena utvrđena je jasna razlika u obrascu ekspresije gena u listu i korenu kod oba genotipa u obe vremenske tačke. Kod tolerantnog genotipa, geni sa najizraženijim smanjenjem ekspresije identifikovani nakon 6 i 24h stresa su uključeni u odgovor biljke na stres, a kod osetljivog genotipa u proces biofortifikacije. Gen sa najizraženijim povećanjem ekspresije nakon 6h sati stresa kod tolerantnog genotipa nema poznatu funkciju, dok je gen sa najizraženijim povećanjem ekspresije nakon 24h uključen u proces fotosinteze. Kod osetljivog genotipa, isti neokarakterisani, novotkriveni gen je identifikovan u obe vremenske tačke kao gen sa najizraženijim povećanjem ekspresije. Identifikacijom DEG profila između lista i korena kukuruza u uslovima stresa niskim temperaturama omogućava se otkrivanje molekularnih mehanizama koji regulišu odgovor biljke na stres, što doprinosi stvaranju genotipova adaptiranih na uslove izazvane klimatskim promenama.

Ključne reči: kukuruz, stress niskim temperaturama, sekvenciranje, diferencijalna ekspresija gena

Zahvalnica: Rad je rezultat istraživanja u okviru ugovora 451-03-47/2023-01/200040 od 17.01.2023. godine, finansiranog od strane Ministarstva nauke, tehnološkog razvoja i inovacija Republike Srbije.

GENE EXPRESSION ANALYSIS (mRNA) OF MAIZE UNDER LOW TEMPERATURE STRESS IN EARLY GROWTH STAGES

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Two maize inbred lines, one susceptible (L1) and one tolerant (L2), were grown under optimal conditions up to V3 stage. At this point, both lines were exposed to low temperatures (10/8° C; photoperiod: 12/12h; light intensity: 700 μmol/m2/s) for a period of 6 and 24 hours. After the treatments, root and leaf samples were taken. Sequencing of prepared cDNA libraries (*paired-end 150 sequencing Illumina® Novaseq 6000*) enabled identification and analysis of differentially expressed genes (DEG) between two conditions/groups by using DESeq2 R package (R software). Identification of DEG between leaves and roots revealed a clear difference in gene expression pattern for both genotypes at both time points (6 and 24 hours). The most downregulated genes identified for both 6 and 24h stress are involved in plant stress response and biofortification in the tolerant and susceptible lines, respectively. In the tolerant genotype, the most upregulated gene after 6h stress is with unknown function and the most upregulated gene after 24h stress is involved in photosynthesis. Considering the susceptible genotype, the same uncharacterized, newly discovered gene was identified for both time points as the most upregulated gene. Revealing DEG profiles between maize leaves and roots under cold stress will facilitate uncovering the molecular mechanisms which regulate plant stress response and further contribute to development of genotypes adapted to climate-changing conditions.

Key words: maize, low temperature stress, sequencing, differentially expressed genes

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II-POS-30

UGRADNJA *GA1-S* GENA U RODITELJSKE LINIJE HIBRIDA KUKURUZA BELOG ZRNA POMOĆU MOLEKULARNIH MARKERA

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U Institutu za kukuruz "Zemun Polje" postoji program selekcije pomoću molekularnih markera (MAS) čiji je cilj ugradnja gena za inkompatibilnost *Ga1-S* u linije kukuruza koje su roditeljske komponente hibrida belog zrna. Glavni cilj ovog rada je bio stvaranje linija kukuruza belog zrna sa potpunom *cross*-inkompatibilnošću sa stranim polenom pomoću molekularnih makera. Molekularnim markerima koji su blisko vezani za *Ga1-S* gen uspešno su identifikovane heterozigotne biljke (50%) nakon sva tri povratna ukrštanja. Rezultati utvrđivanja procenta genoma rekurentnog roditelja (RPG) u BC_3 generaciji pokazali su vrednost iznad očekivane kod 69% potomstva, dok je kod određenog broja RPG iznosio 99% što predstavlja vrednost koja se teoretski dostiže u BC_6 generaciji. Od 264 pojedinačne biljke BC_3F_2 generacije, 70 (26,5%) su bili dominantni homozigoti, što je u skladu sa očekivanim prema pravilima Mendelovog nasleđivanja. Potomstva BC_3F_2 dominantno homozigotnih biljaka posejana su sa kukuruzom žutog zrna iste grupe zrenja radi provere *cross*-inkompatibilnosti. Nijedno od dobijenih potomstava nije imalo 100% belo zrno, najverovatnije usled prisustva gena modifikatora koji menjaju efikasnost isključivanja polena, ili je došlo do gubljenja ovih gena prilikom povratnog ukrštanja. Moglo bi se očekivati da bi se primenom funkcionalnih markera (stvorenih na osnovu polimorfizama sekvenci unutar samog gena vezanog za fenotipsku osobinu) uspešno prevazišle uočene prepreke i poboljšala efikasnost MAS za prenos željenih gena koji kontrolišu prostu ili složenu osobinu u gajene kulture.

Ključne reči: *Ga1-S,* kukuruz, selekcija pomoću molekularnih markera

Zahvalnica: Ovo istraživanje finansirano je od strane Ministarstva nauke, tehnološkog razvoja i inovacija Republike Srbije (broj ugovora: 451-03-47/2023-01/200040).

MARKER ASSISTED *GA1-S* INCORPORATION INTO WHITE MAIZE HYBRID´S PARENTAL LINES

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Maize Research Institute Zemun Polje has a marker assisted backcross breeding (MABB) program aimed to incorporate the strong allele of incompatibility gene *Ga1* into parental components of the hybrids with specific traits (white kernel). The main objective of this research was marker assisted development of the white maize hybrid´s parental lines with the complete cross-incompatibility to foreign pollens. *Ga1-S*-tightly-linked molecular markers successfully identified heterozygous plants with the percentage of approximately 50% after all three backcrossing. Regarding the background selection, 69% of progenies had recurrent parent's genome (RPG) above the theoretical value for BC_3 generation. Also, a few individuals even had 99%, the value theoretically achieved in BC_6 generation, showing that MABB made a genetic gain in RPG recovery. Foreground selection in this generation aimed to identify homozygous dominant individuals. Out of 264 BC_3F_2 plants, 70 (26.5%) were dominant homozygotes, which is in accordance with the expected Mendelian ratio. Progenies of the BC_3F_2 homozygous dominant plants were planted alternatively with yellow-kernel maize of the same maturity to check cross-incompatibility. Unfortunately, none of the dominant progenies had a 100% white kernel, most likely due to the presence of modifier genes that affect the effectiveness of pollen exclusion or that, alternatively, modifiers were lost during the backcrossing. It could be expected that successfully employed functional markers (developed from the sequence polymorphisms present within functional gene(s) associated with phenotypic trait variations) would outbalance the noted impediments and enhance MABB efficiency to transfer the desired gene(s) controlling simple or complex trait(s) into cultivated varieties.

Key words: *Ga1-S,* maize, marker assisted backcross breeding, foreground selection, background selection

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II-POS-31

GERMINACIJA NAKON PREDTRETMANA SEMENA I FORMIRANJE KLIJANACA KOD KUKURUZA

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Tokom čuvanja, dolazi do propadanja semena i gubitka životne sposobnosti, energije i kvaliteta. S obzirom da se set međusobno povezanih biohemijskih promena, tj. aktivacija enzima, sinteza hormona–stimulatora rastenja, razgradnja inhibitora klijanja i reparacija ćelijskog oštećenja, javlja kao odgovor na izlaganje semena agensima predtretmana, eksperiment je imao za cilj procenu efikasnosti različitog prajminga semena na vigor i ukupnu performansu klijanaca kukuruza. Izvršena je evaluacija četiri sorte kukuruza čuvane 5 i 35 godina u srednjoročnim uslovima (t=4-5°C; RH=40-45%), standardnim testiranjem klijavosti na filter papiru (BP, 20⇔30°C, ISTA *Rules*) i *cold* testom. Poređenjem sa netretiranim semenom, u suboptimalnim uslovima *cold* testa je utvrđen pozitivan efekat primene predtretmana semena na klijanje, uključujući i energiju klijanja, kao i na smanjenje broja mrtvih semena, naročito izražen kod dugo čuvanog semena. Ispitivanjem ranog porasta klijanaca, samo u *cold* testu je evidentiran pozitivan uticaj predtretmanana na rast klijanaca dugo čuvanog semena. Međutim, kod semena kraćeg perioda čuvanja, utvrđeno je da je uticaj predtretmana na izduživanje klijanca uglavnom determinisan genotipom. Testiranjem na filter papiru semena i kraćeg i dugog perioda čuvanja, utvrđen je pozitivan efekat KNO_3 predtretmana na svežu masu korena, odnosno pozitivan efekat H_2S predtretmana na svežu masu celog klijanca. Oba predtretmana su uticala na porast suve mase korena samo kod dugo čuvanog semena, odnosno na porast suve mase izdanka semena kraćeg perioda čuvanja. Testiranjem u uslovima *cold* testa semena i kraćeg i dugog perioda čuvanja, utvrđeno je da su svi predtretmani doprineli porastu sveže i naročito suve mase klijanca.

Ključne reči: *acidic-priming*, *halo-priming*, dužina klijanca, masa klijanca, *Zea mays* L.

Zahvalnica: Ovo istraživanje je finansiralo Ministarstvo nauke, tehnološkog razvoja i inovacija Republike Srbije kroz projekat (ev. br.) 451-03-47/2023-01/200040.

POST-PRIMING GERMINATION AND SEEDLING ESTABLISHMENT IN MAIZE

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During storage, seed deteriorates, loses viability and quality. Given that a set of interlinked biochemical changes (i.e. activation of enzymes, synthesis of growth-promoting substances, germination inhibitors' metabolism and cell damage repair) occurs in response to seed exposure to priming stimuli, this experiment aimed at estimating the efficiency of different seed priming on vigour and overall maize seedlings performance. Four maize landraces kept for 5 and 35 years under cold storage–CS (t=4-5°C; RH=45-50%) were evaluated, using standard seed germination test on filter paper (BP, 20⇔30°C, ISTA Rules) and cold test. Compared to unprimed seeds (control), in suboptimal conditions of cold test, positive effect of seed priming on germination, including germination energy, as well as on the reduction of the number of dead seeds, was determined, while being more pronounced in seeds of long CS lifespan. In addition, a positive effect of seed priming on early seedlings growth was recorded in seeds of long CS lifespan, being mainly genotype-specific in seeds of short CS lifespan. For seeds of both the short and long CS lifespans, standard testing on filter paper showed that the halo–KNO_3 and acidic–H_2S priming contributed to root, i.e. whole seedling fresh weight increase, respectively. Both seed priming contributed to root i.e. shoot dry weight in seeds of long i.e., short CS lifespan, respectively. Under conditions of cold test, in seeds of both the short and long CS lifespans, a positive impact of all evaluated seed priming on the seedlings fresh and especially dry weight was observed.

Kew words: acidic-priming, halo-priming, seedling length, seedling weight, Zea mays L.

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II-POS-32

SADRŽAJ KAROTENOIDA I TOKOLA U PANELU INBRED LINIJA KUKURUZA IZ GEN BANKE

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Karotenoidi i sastojci vitamina E (tokoli) su važna prirodna jedinjenja koja se nalaze u zrnu kukuruza i doprinose njegovoj nutritivnoj vrednosti i zdravstvenim prednostima. Cilj ovog istraživanja bio je da se analizira sadržaj i odnos između luteina, zeaksantina, α- i β-kriptoksantina, , α- i β-karotena, α-, γ- i δ-tokoferola i α- i β-tokotrienola u zrnu 88 uzoraka kukuruza sa različitim udelom nativne germplazme (sorte kukuruza iz Jugoistočne Evrope) iz hrvatske genebanke kukuruza. Poljsko ispitivanje sprovedeno je na dve lokacije u Hrvatskoj u 2019. godini. Iz celog zrna kukuruza analiziran je sadržaj karotenoida i tokola. Nakon ekstrakcije, karotenoidi i tokoli su odvojeni i kvantifikovani istovremeno tečnom hromatografijom visokih performansi (HPLC). Opsezi sadržaja zrna analiziranih jedinjenja u μg g^{-1} na osnovu suve mase bili su: lutein (0,8 – 32,7), zeaksantin (1,5 – 21,6), α-kriptoksantin (0,2 – 8,6), β–kriptoksantin (0,2 – 5,9), α -karoten (0,1 – 2,2), β-karoten (0,1 – 4,2), α-tokoferol (0,8 – 30,4), γ-tokoferol (0,8 – 30,4). δ-tokoferol (0,3 – 4,5), α-tokotrienol (1,2 – 7,9) i γ-tokotrienol (0,9 – 19,3) što ukazuje na visoku varijabilnost među uzorcima u banci gena. Kao što se i očekivalo, najjače pozitivne korelacije bile su između zeaksantina i β-kriptoksantina, kao i između γ- i δ-tokoferola. Generalno, rezultati pokazuju da je moguća istovremena selekcija na povećan sadržaj karotenoida i jedinjenja vitamina E.

Ključne reči: kukuruz, inbred linije, karotenoidi, tokoli

CONTENT OF CAROTENOIDS AND TOCOLS IN A PANEL OF MAIZE INBRED LINES FROM THE GENE BANK

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Carotenoids and vitamin E constituents (tocols) are important natural compounds found in maize grain that contribute to its nutritional value and health benefits. The aim of this study was to analyze contents and relations among lutein, zeaxanthin, α- and β-cryptoxanthin, α- and β-carotene, α-, γ- and δ-tocopherol, α- and γ-tocotrienol content in grain of 88 accessions of maize from Croatian maize genebank. A field trial with 88 maize inbred lines having different proportions of native germplasm (maize landraces from Southeastern Europe) was conducted at two locations in Croatia in 2019. Contents of carotenoids and tocols were analyzed from whole maize grain. After extraction, carotenoids and tocols were separated and quantified simultaneously using a HPLC instrument. The ranges of grain content of the analyzed compounds in μg g^{-1} on a dry weight basis were: lutein (0.8 – 32.7), zeaxanthin (1.5 – 21.6), α-cryptoxanthin (0.2 – 8.6), β–cryptoxanthin, (0.2 – 5.9), α -carotene (0.1 – 2.2), β-carotene (0.1 – 4.2), α-tocopherol (0.8 – 30.4), γ-tocopherol (2.9 – 80.0), δ-tocopherol (0.3 – 4.5), α-tocotrienol (1.2 – 7.9) and γ-tocotrienol (0.9 – 19.3) suggesting high variability among the genebank accessions. As expected, the tightest positive correlations were between zeaxanthin and β-cryptoxanthin, as well as between γ- and δ-tocopherol. Generally, it suggests that selection for carotenoids and vitamin E compounds could be achieved simultaneously.

Key words: maize, inbred lines, carotenoids, tocols

II-POS-33

FUZARIOTOKSINI I AFLATOKSINI U KUKURUZU

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Ova studija je sprovedena sa ciljem da se ispita prirodna pojava toksigenih vrsta gljiva i sadržaj fumonizina (FB), ukupnih aflatoksina (AFLA), zearalenona (ZEA) ideoksinivalenola (DON) u zrnu kukuruza, uskladištenom neposredno nakon berbe 2022. godine. Prikupljeni su uzorci zrna kukuruza sa tri lokacije (Zemun Polje, Školsko Dobro i Zagajica) u Srbiji i analizirani na prisustvo mikotoksina. Nakon sušenja i mlevenja, uzorci su homogenizovani sa 25 ml 70% rastvora metanola i destilovanom vodom (3:1), a zatim ekstrahovani. Kvantifikacija ukupnog sadržaja mikotoksina izvršena je metodom imunoapsorpcionih enzima (ELISA) prema uputstvu za upotrebu proizvođača (Tecna S.R.L., Italija, Celer Test Kit). Analizom 100 uzoraka zrna kukuruza utvrđena je velika varijabilnost u koncentraciji ispitivanih mikotoksina. Svi ispitivani uzorci su bili pozitivni na najmanje jedan od ispitivanih mikotoksina (FB, AFLA, ZEA, DON). Fumonizin je detektovan u koncentraciji od 0 do 0,268 ppm, ukupni aflatoksin od 0,423 do 3,925 ppb, zearalenon od 0 do 9,685 ppb, i deoksinivalenol od 0,005 do 3,581 ppm. U svim ispitivanim hibridima, analize mikotoksina su pokazale da su nivoi FB, AFLA, ZEA i DON bili ispod maksimalno dozvoljenih nivoa propisanih zakonodavstvom Evropske unije i Republike Srbije, namenjenom za kukuruz i proizvode od kukuruza. Neophodno je kontinuirano praćenje sadržaja mikotoksina, s obzirom da se isti menja iz godine u godinu.

Ključne reči: fuzariotoksini, aflatoksini, kukuruz

Zahvalnica: Ovo istraživanje finansirano je od strane Ministarstva nauke, tehnološkog razvoja i inovacija Republike Srbije (broj ugovora: 451-03-47/2023-01/200040).

FUSARIOTOXINS AND AFLATOXINS IN MAIZE KERNELS

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This study was conducted to investigate the natural occurrence of toxigenic fungal species and the levels of fumonisin (FB), zearalenone (ZEA), deoxynivalenol (DON), and total aflatoxin (AFLA) in corn kernels stored immediately after harvest in 2022. Samples of maize kernels from two locations (Zemun Polje and Zagajica) in Serbia were collected and analyzed for the presence of mycotoxins. After drying and milling, the samples were homogenized with 25 ml of 70% metanol solution and distilled water (3:1) and then extracted. Quantification of total mycotoxin content was performed using the immunoapsorption enzyme method according to the manufacturer's instructions (Tecna S.R.L., Italy, Celer Test Kit). The analysis of 100 maize kernels samples was determined by a great variability in the concentration of mycotoxins studied. All samples tested were positive for at least one of the mycotoxins tested (fumonisin, aflatoxin, zearalenone or deoxynivalenol). Fumonisin is determined at a concentration of 0 to 0.268 ppm, total aflatoxin at a concentration of 0.423 to 3.925 ppb, zearalenone at a concentration of 0 to 9.685 ppb, while deoxynivalenol is detected at a concentration of 0.005 to 3.581 ppm. In all tested hybrids, mycotoxin analyses showed that the levels of AFLA, DON, ZEA and FBs were below the maximum permissible levels established by the legislation of the European Union and the Republic of Serbia in maize intended for maize and maize products. Continuous monitoring of mycotoxin content is necessary as it changes from year to year.

Key words: fusariotoxins, aflatoxins, maize kernels

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II-POS-34

POREĐENJE SSR I SNP MARKERA U PROCENI GENETIČKOG DIVERZITETA I STRUKTURE POPULACIJE GENOTIPOVA KUKURUZA

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Tačna procena genetičkog diverziteta i analiza strukture populacije pruža vredne informacije za karakterizaciju, sakupljanje i upravljanje germplazmom kukuruza. Takođe, asocijativno mapiranje koje je važno za disekciju genetičke osnove kompleksnih kvantitativnih osobina oslanja se na informacije o strukturi populacije. U ovom istraživanju su u tu svrhu primenjena dva najvažnija i najpoželjnija tipa molekularnih markera - SSR i SNP. Za ovo istraživanje odabran je set od 40 inbred linija kukuruza sa različitim tipom zrna (kukuruz šećerac, kokičar) i bojom zrna (bela, žuta, narandžasta). Vrednosti parametara genetičke raznovrsnosti (broj alela, prosečan broj alela po lokusu, učestalost glavnih alela, mera nivoa polimorfizma -PIC, diverzitet gena i heterozigotnost) izračunate u softveru Power Marker v3.5 imale su veće vrednosti za SSR u odnosu na SNP markere. U poređenju sa SNP markerima, SSR markeri su pružili više informacija o genetičkoj raznolikosti. Proučavana je genetička srodnost genotipova kukuruza. Genetičke distance su izračunate primenom Rogers-ovog koeficijenta za oba tipa markera, a za generisanje dendrograma korišćena je UPGMA metoda grupisanja. Takođe, matrice distanci su korišćene za analizu glavnih komponenti (PCoA). Genetička struktura testiranih genotipova određena je primenom softvera STRUCTURE, i nije pokazala značajnije razlike u poređenju sa klaster i PCoA analizom podataka. Metod hijerarhijskog grupisanja, PCoA i klaster analiza zasnovana na Bajesovom pristupu su pokazali umerenu saglasnost sa dostupnim podacima o pedigreu/poreklu ili tipu/boji zrna kukuruza za oba tipa molekularnih markera. Rezultati analize ukazuju da SNP markeri omogućavaju dobijanje veće rezolucije pri ispitivanju strukture populacije, ali su SSR markeri efikasniji u analizi diverziteta.

Ključne reči: kukuruz, genetički diverzitet, struktuta populacije, SNP, SSR

Zahvalnica: Ovo istraživanje finansirano je od strane Ministarstva nauke, tehnološkog razvoja i inovacija Republike Srbije (broj ugovora: 451-03-47/2023-01/200040).

COMPARISON OF SSR AND SNP MARKERS IN THE ASSESSMENT OF GENETIC DIVERSITY AND POPULATION STRUCTURE OF MAIZE GENOTYPES

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The accurate evaluation of genetic diversity and population structure analysis provides valuable information for maize germplasm characterization, collection and management. Also, genome-wide association mapping important for the dissecting of genetic basis of complex quantitative traits relies on the information of population structure. In this study, the two most important and preferred genetic markers SSR and SNP were applied for this purpose. A set of 40 maize inbred lines with different kernel type (sweet maize, popcorn) and kernel color (white, yellow, orange) was chosen for this study. The values of parameters of genetic diversity (number of alleles, average number of alleles per locus, major allele frequency, Polymorphic Information Content -PIC, gene diversity and heterozygosity) calculated in Power Marker v3.5 software were higher for SSR than for SNP markers. Thus, compared to SNPs, SSRs provided more information on genetic diversity. Genetic relatedness among the maize genotypes was studied. Genetic distances according to Rogers's coefficient were calculated for both types of markers and UPGMA clustering method was used to generate a dendrogram. Moreover, distance matrices were used for Principle Coordinate Analysis (PCoA) analysis. Genetic structure of tested genotypes was determined using STRUCTURE software, without a considerable difference in comparison to cluster and PCoA data analysis. Hierarchical clustering method, PCoA and Bayesian model-based clustering showed moderate accordance to available pedigree/origin or kernel type/color data for both types of molecular markers. The results of the analysis suggest that resolution of population was higher with SNP markers, but SSR were more efficient for diversity analysis.

Key words: maize, genetic diversity, population structure, SNP, SSR

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II-POS-35

DIFERENCIJALNA EKSPRESIJA miRNK KORENA TOLERANTNE I OSETLJIVE LINIJE KUKURUZA U V3 FAZI RASTA U USLOVIMA STRESA NISKIM TEMPERATURAMA

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MikroRNK (miRNK) su klasa malih nekodirajućih RNK molekula koji imaju ulogu u odgovoru biljke na stres. Kukuruz je jedan od najvažnijih useva u svetu i proizvodnja kukuruza je najpodložnija negativnim efektima različitih abiotičkih stresova tako da je identifikacija miRNK i njihove uloge u odgovoru biljaka na stres od velike važnosti. U cilju izučavanja ekspresije miRNA, za eksperiment su korišćene tolerantna (L_T) i osetljiva (L_S) linija kukuruza na stres niskim temperaturama. U V3 fazi rasta, obe linije su izložene dejstvu stresa (10/8° C; fotoperiod: 12/12h) u trajanju od 6 i 24 sata. Kontrolne biljke su do kraja eksperimenta gajene na optimalnoj temperaturi. Uzeti su uzorci korena tretiranih i kontrolnih biljaka za ispitivane tačke, izolovana je RNK ispitivanih uzoraka, pripremljene su cDNK biblioteke i urađeno je *Next Generation Sequencing* (NGS) sekvenciranje. Diferencijalna ekpresija gena između kontrole i tretmana u obe ispitivane tačke kod osetljive i tolerantne linije je analizirana primenom EdgeR paketa (R softver). Najveći broj miRNA posle tretmana je detektovan kod tolerantne linije posle 24h stresa (4,244,996). Ukupan procenat istovremeno eksprimiranih miRNA i u kontrolnim i u uslovima tretmana je bio veći kod tolerantne linije. Znatno veći ukupan broj diferencijalno eksprimiranih miRNA je utvrđen kod tolerantne linije u odnosu na osetljivu u obe tačke tretmana. Ukupan broj diferencijalno eksprimiranih miRNA i posle 6h i posle 24h sati tretmana kod tolerantne linije je bio približno isti (~60), a isto tako i kod osetljive linije (~20). Rezultati istraživanja ukazuju na moguću značajnu ulogu miRNK u regulaciji odgovora kukuruza na stres niskim temperaturama.

Ključne reči: kukuruz, abiotički stres, transkriptomika, miRNK

Zahvalnica: Ovo istraživanje je podržalo Ministarstvo prosvete, nauke i tehnološkog razvoja, Republika Srbija, ugovor broj 200040 (Institut za kukuruz "Zemun Polje") (RS-200040)

DIFFERENTIAL EXPRESSION OF MAIZE ROOTS miRNA OF TOLERANT AND SENSITIVE INBRED LINE IN V3 GROWTH PHASE UNDER LOW TEMPERATURE STRESS CONDITIONS

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MicroRNAs (miRNAs) are a class of non-coding RNAs with regulatory role in stress response. Considering the fact that maize is one of the most important crops and its production is most vulnerable to various abiotic stresses, identification of miRNA and their role in plant response to stress is of great importance. For identification of miRNA involved in maize response to chilling stress, an experiment with tolerant (L_T) and sensitive (L_S) maize inbred was done. Two lines were grown to V3 growth stage under optimal conditions and then exposed to chilling stress (10/8° C; photoperiod: 12/12h; 10° C), and root samples were taken 6 and 24h after stress onset (treatment and control). RNA extraction, cDNA library preparation, *Next Generation Sequencing* (NGS) and data analysis followed. Package EdgeR (R software) is used to calculate the differential expression level. The highest number of expressed miRNAs after treatment was detected in the tolerant line after 24h of stress (4,244,996). The total percentage of co-expressed miRNAs in both control and treatment conditions was higher in the tolerant line. A significantly higher total number of differentially expressed miRNA was found in the tolerant line compared to the sensitive in both treatment points. The total number of differentially expressed miRNA both after 6h and after 24h of treatment in the tolerant line was approximately the same (~60), as well as in the sensitive one (~20). The results of the research indicate a possible significant role of miRNA in the regulation of maize's response to low temperature stress.

Key words: maize, abiotic stress, transcriptomic, miRNA

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II-POS-36

KVALITET ZRNA I MOGUĆNOSTI PRIMENE DESET NOVORAZVIJENIH ZP HIBRIDA KUKURUZA

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Proces oplemenjivanja hibrida kukuruza (*Zea mays* L.) decenijama je bio usmeren ka dobijanju viših prinosa zrna i povećanju tolerancije na faktore životne sredine i biološke stresore, dok je kvalitet zrna bio od sekundarnog značaja. Rezultati višegodišnjih istraživanja ukazuju na bojazan od smanjenja kvaliteta zrna kao direktne posledice oplemenjivanja na veći prinos. Ova studija je imala za cilj da ispita kvalitet zrna deset nedavno razvijenih ZP hibrida kukuruza kako bi se utvrdila njihova pogodnost za različite primene. Tri uzastopne godine analizirani su fizička svojstva i hemijski sastav sedam žutih, dva crvena zubana i jednog hibrida kokičara različitih grupa zrenja. Rezultati su pokazali određene varijacije koje su se manifestovale kao statističke razlike u pogledu pojedinih osobina kvaliteta zrna,a koje se mogu pripisati faktorima sredine, kao što su temperaturne fluktuacije i godišnji nivoi padavina, kao i genetska stabilnost ispitivanih hibrida kukuruza. Apsolutna masa zrna, karakteristika značajnaza mokro mlevenjezbog višeg prinosa skroba i proteina i manjeg prinosa vlakana, kretala se od 136,60 g u kokičaru ZP 6119k do 400,40 g u žutom zubanu ZP 6364. Udeo tvrdog endosperma, koji utiče na efikasnost mlevenja zrna, kretao se od 48,23% (ZP 4123) do 75,11% (ZP 6119k). Najviši sadržaj skroba (72,31%) utvrđen je kod hibrida ZP 4123, dok su proteini,esencijalni makronutrijenti,bili najzastupljeniji u ZP 6119k (12,53%) i ZP 6715 (11,07%). Dobijeni rezultati ukazuju da analizirani hibridi kukuruza mogu pružiti različite mogućnosti primene u proizvodnji hrane za ljude i životinje, kao i drugim industrijama.

Ključne reči: hibridi kukuruza, fizičke osobine, hemijski sastav, tehnološki kvalitet, integralno kukuruzno brašno.

Zahvalnica: Rad je podržalo Ministarstvo nauke, tehnološkog razvoja i inovacija Republike Srbije, ugovor broj 451-03-9/2021-14/200040 i Evropska komisija kroz projekat TWINNING GREEN-EDITING VIBES FOR FΘΘD, broj 101059942. Θ

GRAIN QUALITY AND POSSIBILITIES FOR APPLICATION OF TEN RECENTLY DEVELOPED ZP MAIZE HYBRIDS

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The hybrid maize (*Zea mays* L.) breeding process has, for decades, been focused on obtaining higher grain yields and increased tolerance towards environmental and biological stressors, while grain quality was of secondary importance. The results of long-term research indicate a concern about a decrease in grain quality as a direct result of breeding for higher yield. This study aimed to investigate the grain quality of ten recently developed ZP maize hybrids to determine their suitability for different applications. The physical properties and chemical composition of seven yellow dents, two red dents, and one popcorn hybrid of different maturity groups, were analyzed for three consecutive years. The results showed some variation manifested as statistical differences regarding individual grain quality traits that may be attributed to environmental factors, such as temperature fluctuations and yearly precipitation levels, as well as the genetic stability of the studied maize hybrids. The 1000-kernel weight, a preferred wet-milling characteristic associated with higher starch and protein yield and lesser fiber contents, ranged from 136.60 g in popcorn hybrid ZP 6119k to 400.40 g in yellow dent ZP 6364. Hard endosperm share, which affects the efficacy of grain milling, ranged from 48.23% (ZP 4123) to 75.11% (ZP 6119k). The highest starch content (72.31%) was determined in hybrid ZP 4123, while ZP 6119k (12.53%) and ZP 6715 (11.07%) were the most abundant in proteins, among essential macronutrients. The obtained results indicate that the analyzed maize hybrids may provide various possibilities for application in food, feed, and other industries.

Key words: maize hybrids, physical traits, chemical composition, technological quality, whole-grain maize flour.

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II-POS-37

PROCENA GENETIČKE HOMOZIGOTNOSTI INBRED LINIJA KUKURUZA

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Inbred linija se može smatrati genetički čistom ili homozigotnom ako udeo heterozigotnih lokusa ne prelazi 5%. Predosnovno seme kao prva kategorija sortnog semena se koristi za proizvodnju osnovnog semena i mora biti 99,9% homozigotno. Cilj ovog istraživanja bio je da se proceni nivo genetičke homozigotnosti dve inbred linije Instituta za kukuruz „Zemun Polje" (L1 i L2) nakon šest generacija samooplodnje. Za ovu procenu su koriććeni morfološki UPOV (*International Union for the Protection of New Varieties of Plants*), biohemijski i molekularni *Simple Sequence Repeats* (*SSR*) markeri. Najdiskriminativniji u ovoj proceni su bili morfološki markeri, praćeni UTLIEF (*Ultra Thin Layer Isoelectric Focusing)* i SSR markerima. Na osnovu analize fenotipske uniformnosti, STDEV pristup za metrički merene osobine i *off-types* pristup korišćen za vizuelnu procenu osobina, detektovali su nezadovoljavajući nivo uniformnosti obe proučavane inbred linije (90% i 92,5%), respektivno. Nakon UTLIEF elektroforeze (pH 5–8/2–11), vizualizacijom i poređenjem profila rezervnih proteina (albumina i prolamina) utvrđen je nezadovoljavajući stepen homozigotnosti (94% za L1, tj.96% za L2, respektivno). Molekularnom analizom je potvrđen nezadovoljavajući stepen homozigotnosti ispitivanih inbred linija. Dobijeni rezultati ukazuju na potrebu za dodatnom generacijom inbridinga radi dobijanja čistih inbred linija visoke genetičke homozigotnosti kao neophodne karakteristike roditeljske komponente komercijalnog hibrida.

Ključne reči: fenotipska uniformnost, kukuruz, SSR markeri, UTLIEF metod

Zahvalnica: Ovo istraživanje finansirano je od strane Ministarstva nauke, tehnološkog razvoja i inovacija Republike Srbije (broj ugovora: 451-03-47/2023-01/200040).

GENETIC HOMOZYGOSITY ASSESSMENT OF MAIZE INBRED LINES

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An inbred line may be considered genetically pure or homozygous if the proportion of heterozygous loci does not exceed 5%. Pre-basic seed is the first category of varietal seed used for basic seed production and it has to be 99,9% homozigous. The aim of this study was to estimate the level of genetic homozygosity of two Maize Research Institute Zemun Polje (MRIZP) inbred lines (L1 and L2) after six generation of selfing. Morphological UPOV (International Union for the Protection of New Varieties of Plants), biochemical and molecular simple sequence repeats (SSR) markers were used for this assessment. The most discriminative were morphological markers, followed by Ultrathin-layer isoelectric focusing (UTLIEF) and SSRs. Based on the analysis of phenotypic uniformity, the STDEV approach for metrically measured traits and the off-types approach used for visually assessed traits both detected an unsatisfactory level of uniformity of both studied inbred lines (90% and 92.5%), respectively. After UTLIEF electrophoresis (pH 5–8/2–11), visualization and comparison of storage protein (albumins and prolamins) profiles revealed an unsatisfactory level of homozygosity (94% for L1 and 96% for L2, respectively), which was also confirmed by molecular analysis. The obtained results indicate the need for an additional generation of selfing in order to obtain pure inbred lines of high genetic homozygosity as a prerequisite characteristic of a commercial hybrid's parental component.

Key words: maize, phenotypic uniformity, SSR markers, UTLIEF method

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II-POS-38

UČESTALOST TOKSIGENIH VRSTA GLJIVA NA ZRNU HIBRIDA KUKURUZA RAZLIČITE FAO GRUPE ZRENJA U SRBIJI

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U ovom istraživanju je analizirana učestalost prisustva toksigenih vrsta gljiva na zrnu šest hibrida kukuruzaiz različitih FAO grupa zrenja (ZP 341, ZP 427, ZP 434, ZP 560, ZP 606, ZP 666), Uzorci su prikupljeni u vreme berbe, iz tri različita lokaliteta (Zemun Polje, Bečej, Šabac) u Srbiji. Koristeći standardne mikološke metode izolacije, istraživači su izolovali toksigene vrste gljiva. Dobijene kolonije su prečišćene kako bi se dobila čista kultura gljiva. Ove kulture su potom korišćene za identifikaciju različitih vrsta gljiva. Kulture gljiva su gajene na različitim podlogama kao što su krompir-dekstroza podloga (PDA), podloga sa fragmentima sterilnog lista karanfila (CLA) i sintetička podloga (SNA). Inkubacija kultura je obavljena pri kontrolisanoj temperaturi od 25±1°C. Identifikacija izolovanih vrsta je izvršena prema Nelsonui sar. (1983). Statistička analiza prikupljenih podataka izvedena je korišćenjem analize varijanse (ANOVA), uz primenu paketa Statistica 10 (StatSoft, Inc., SAD). Značajnost razlika između srednjih vrednosti parametara je ocenjena putem F-testa pri nivou značajnosti od $P \leq 0,05$. Tokom mikoloških istraživanja zrna kukuruza, potvrđeno je prisustvo toksigenih gljiva iz tri roda: *Aspergillus*, *Fusarium* i *Penicillium*. U lokalitetima koji su obuhvaćeni istraživanjem, gljiva *Fusarium verticillioides* je bila najčešće izolovana, sa maksimalnom učestalošću od 36% kod većine ispitivanih hibrida. Prisustvo *Aspergillus* spp. se kretalo od 0 do 19%, dok je prisustvo *Penicillium* spp. variralo od 0 do 25%. Imajući u vidu povoljne agroekološke uslove u Srbiji za razvoj toksigenih gljiva i njihovih mikotoksina, neophodno je redovno sprovoditi kontrolu nad sadržajem mikotoksina u zrnu kukuruza, kako tokom žetve tako i nakon nje.

Ključne reči: kukuruz, *Aspergillus*, *Fusarium*, *Penicillium*, toksigene gljive

Zahvalnica: Rad je podržalo Ministarstvo nauke, tehnološkog razvoja i inovacija Republike Srbije, ugovor broj 451-03-9/2021-14/200040.

FREQUENCY OF TOXIGENIC SPECIES OF FUNGI ON HYBRID MAIZE GRAIN OF DIFFERENT FAO CEREAL GROUPS IN SERBIA

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The frequency of the presence of toxigenic fungal species on the grain of six maize hybrids from different FAO ripening groups (ZP 341, ZP 427, ZP 434, ZP 560, ZP 606, ZP 666) was analyzed. Representative grain samples were collected at the time of harvest, from three different localities (Zemun Polje, Bečej, Šabac) in Serbia. Toxigenic species were isolated by standard mycological methods. After isolation, colonies were purified to obtain a pure fungal culture. These cultures were used to identify different types of fungi. Fungal cultures were grown on different media such as potato-dextrose media (PDA), sterile clover leaf fragment media (CLA) and synthetic media (SNA). Cultures were incubated at a controlled temperature of 25±1°C. The identification of isolated species was performed according to Nelson et al. (1983). Statistical analysis of the collected data was performed using analysis of variance (ANOVA), using the Statistica 10 package (StatSoft, Inc., USA). The significance of the differences between the mean values of the parameters was assessed using the F-test at a significance level of $P \leq 0.05$. During the mycological research of maize kernels, the presence of toxigenic fungi from three genera was confirmed: *Aspergillus, Fusarium* and *Penicillium*. In the locations covered by the research, the fungus *Fusarium verticillioides* was the most frequently isolated, with a maximum frequency of 36% in most of the tested hybrids. The presence of *Aspergillus* spp. ranged from 0 to 19%, while the presence of *Penicillium* spp. varied from 0 to 25%. Bearing in mind the favorable agroecological conditions in Serbia for the development of toxigenic fungi and their mycotoxins, it is necessary to regularly control the mycotoxin content in maize grains, both during and after harvest.

Key words: maize, *Aspergillus*, *Fusarium*, *Penicillium*, toxigenic fungi

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II-POS-39

PROCENA LOKALNIH POPULACIJA KUKURUZA ZA OSNOVNE NUTRITIVNE VREDNOSTI POMOĆU NIR SPEKTROSKOPIJE

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Sastav zrna kukuruza, posebno skroba, proteina i lipida, ključan je za ishranu ljudi i životinja. U savremenim programima oplemenjivanja kukuruza prioritet se daje prinosu, što dovodi do smanjenja sadržaja proteina i povećanja sadržaja skroba. U potrazi za zdravijom hranom, lokalne populacije privlače pažnju kao vredan genetički resurs. Cilj ovog rada je da se identifikuju lokalne populacije kukuruza koje su, kada su ukrštane sa divergentnim tester linijama, proizvele potomstvo sa povećanim sadržajem proteina, skroba ili lipida uz održavanje zadovoljavajućeg prinosa. Trideset i jedna lokalna populacija kukuruza je ukrštena sa tri genetički različite linije testera. Nutritivne vrednosti dobijenih *test cross* hibrida procenjene su tokom dve godine i na sedam lokacija korišćenjem bliske infracrvene (NIR) spektroskopije za nedestruktivnu i brzu analizu. Istraživanja su otkrila značajan uticaj sadržaja skroba na prinos hibrida, uz obrnutu korelaciju između sadržaja proteina i skroba. Populacije kukuruza sa visokim sadržajem skroba dale su hibride sa niskim sadržajem proteina i obrnuto. Kod sadržaj lipida u zrnu nisu utvrđene jasne zakonitosti. PCA analiza je identifikovala 12 populacija sa visokim sadržajem proteina, 12 sa visokim sadržajem skroba i 7 sa visokim sadržajem lipida. Lokalne populacije kao što su MB13 i MB197, identifikovane su kao donori osobina važnih za prinos zrna i sadržaj proteina (vrednosti OKS od 0,51* (9,96%) i 0,57* (9,89%) respektivno). Populacija MB594 je pokazala da unosi visok sadržaj skroba (70,39%), dok je MB632 pokazala potencijal za poboljšanje sadržaja lipida (4,39%) i visoko značajnu pozitivnu OKS vrednost od 0,33**. Rezultati rada su pokazali da NIR spektroskopija kao nedestruktivna i brza metoda može poslužiti za procenu sastava zrna kukuruza i da identifikuje lokalne populacije kukuruza za programe oplemenjivanja usmerenih na poboljšanje specifičnih nutritivnih osobina.

Ključne reči: lokalne populacije, osnovne nutritivne vrednosti, bliska IR spektroskopija, genetički resursi

Zahvalnica: Ovo istraživanje finansirano je od strane Ministarstva nauke, tehnološkog razvoja i inovacija Republike Srbije (broj ugovora: 451-03-47/2023-01/200040).

EVALUATION OF MAIZE LANDRACES FOR BASIC NUTRITIONAL TRAITS USING NIR SPECTROPHOTOMETRY

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The composition of maize grains, specifically starch, protein, and lipid content, is crucial for both human and animal nutrition. Modern maize breeding programs often prioritize yield, leading to a decrease in protein content and an increase in starch content. In search of healthier food options, maize landraces have gained attention as a valuable genetic resource. This study aimed to identify maize landraces that, when crossed with divergent tester lines, produced progeny with enhanced protein, starch, or lipid content while maintaining satisfactory yield. Thirty-one local maize populations were crossed with three genetically diverse tester lines. The nutritional values of resulting test cross hybrids were assessed over two years and across seven locations using near-infrared (NIR) spectroscopy for non-destructive and rapid analysis. The study revealed significant impact of starch content on hybrid yield, with an inverse correlation between protein and starch content. Landraces with high starch content produced hybrids with low protein content and vice versa. Lipid content showed no clear pattern. PCA analysis identified 12 landraces with high protein content, 12 with high starch content, and 7 with high lipid content. Certain landraces, such as MB13 and MB197, were identified as donors of traits important for grain yield and protein content (GCA values of 0.51* (9.96%) and 0.57* (9.89%) respectively). Landrace MB594 exhibited a high starch content (70.39%), while MB632 showed potential for lipid content (4.39%) improvement and a highly significant positive GCA value of 0.33**. This study demonstrates the utility of NIR spectroscopy as a non-destructive and rapid method for assessing maize grain composition. It identified promising maize landraces for breeding programs focused on enhancing specific nutritional traits.

Key words: maize landraces, basic nutritional traits, near IR spectrophotometry, genetic resource.

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II-POS-40

DONORI POŽELJNIH ALELA ZA POPRAVKU PRINOSA ZRNA F_1 HIBRIDA KUKURUZA

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U radu su ispitivane linije kukuruza iz različitih ciklusa selekcije dve sintetičke poulacije BSSS i $BSCB_1$. Cilj proučavanja je da se za osobinu prinos zrna proceni koja linija ima najveće relativne vrednosti poželjnih alela za popravku elitnog hibrida. Visoke vrednosti parametra μG^* su imale linije B73(C5), B84(C7), B97(C9) i B99(C10) koje su iz kasnijih ciklusa selekcije, dok su niže vrednosti zabeležene kod linija iz početnog ciklusa selekcije. Linije B73 i B84 nisu imale vrednosti razlike μG^*-(μD^* ili μF^*) signifikantno veće od nule. To podrazumeva da se u procesu selekcije može vršiti direktna samooplodnja i selekcija linija iz ukrštanja (ZPL1 x B73) i (ZPL1 x B84), s obzirom da su obe linije donori pokazale srodstvo sa linijom ZPL1. Druge dve linije B97(C9) i B99(C10) su imale pozitivne i značajne vrednosti poželjnih alela za osobinu prinos zrna, koji nisu bili prisutni u elitnom hibridu ZPL1 x ZPL2. Pošto je za obe linije broj recesivnih nepoželjnih alela bio značajno viši to bi u procesu selekcije trebalo povratno ukrstiti F_1 generaciju sa linijom roditeljem ZPL2, jer su pokazale srodstvo sa tom linijom. Rangiranje linija donora na osnovu njihove vrednosti procenjene preko četiri korišćena parametra je pokazalo dobro slaganje između parametara μG^*, UBND, PTC i NI.

Ključne reči: inbred linije, donori, aleli, prinos

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DONORS OF FAVOURABLE ALLELES FOR THE IMPROVEMENT OF GRAIN YIELD OF F_1 MAIZE HYBRIDS

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Inbred lines of different cycles of selection of two synthetic BSSS and $BSCB_1$ populations were studied with the aim to evaluate which inbred lines had the highest relative values of favourable alleles for the improvement of the elite hybrid. High values of parameters μG^* were estimated in inbreds B73(C5), B84(C7), B97(C9) and B99(C10), which are of the later cycles of selections, while lower values were recorded in inbreds of the initial cycle of selection. The differences of μG^*-(μD^* or μF^*) estimated in inbreds B73 and B84 were not significantly higher from zero. This means that direct self-pollination and the development of inbreds form the crosses (ZPL1 x B73) and (ZPL1 x B84) can be performed in the process of selection, given that both donor inbreds expressed relatedness to the inbred ZPL1. The values of favourable alleles governing grain yield in the other two inbreds B97(C9) and B99(C10) were positive and significant but were not present in the elite hybrid ZPL1 x ZPL2. Since the number of recessive unfavourable alleles was significantly higher for both inbreds, the F_1 generation should be back-crossed to the parental inbred in the selection process because they had expressed relatedness to that inbred. The ranking of donor inbreds based on their value estimated by using four parameters showed a good concordance among parameters μG^*, UBND, PTC and NI.

Key words: inbred lines, donors, alleles, yield

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II-POS-41

KORELACIJA PRINOSA I ZAPREMINE KOKIČAVOSTI KOD HIBRIDA KUKURUZA KOKIČARA

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Kukuruz kokičar koristi se u ishrani i poseduje visokovredne nutritivne osobine. Kao gajena kultura veoma je interesantna i proizvođačima i prodavcima merkantilnog proizvoda. Proizvod kukuruza kokičara je meka kokica koja se formira pod uticajem temperature i visokog pritiska unutar zrna. Zbog toga je za ovaj tip kukuruza od podjednake važnosti prinos zrna, zapremina kokičavosti, kao i kvalitet kokice. Na zapreminu kokičavosti utiče pored osobine genotipa i više drugih faktora kao što su: uslovi proizvodnje, dorade i čuvanja zrna, kao i metode kokanja. Uticaj stresnih faktora kao što su suša, bolesti, mraz, kao i mehaničke povrede zrna u berbi i nakon nje znatno utiču na smanjenje zapremine kokičavosti. Međutim najvažniji uticaj na zapreminu kokičavosti ima sadržaj vlage u zrnu u vreme berbe i u trenutku kokanja. Sadržaj vlage od oko 14 % je optimalan i pri njemu se ostvaruju najviše zapremine kokičavosti. U ovom radu ispitivano je 12 hibrida kukuruza kokičara u toku 2022. godine na dve lokacije u tri ponavljanja. Ispitivane su osobine: prinos hibrida, zapremina kokičavosti i procenat neiskokanog zrna. Prosečan prinos hibrida kretao se od 4,42 t/ha (ZP622/1k) do 8,01 t/ha (ZP 615/2k). Ovakav raspored hibrida bio je i na pojedinačnim lokacijama. Zapremina kokičavosti kretala se od 40 g/cm^3 do 46 g/cm^3. Korelacijom ranga utvrđena je negativna, značajna i jaka zavisnost između ove dve osobine r_s = -0,76**. Procenat neiskokanog zrna kretao se od 0,5 % - 19,36%. Negativna značajna korelacija između dve najvažnije osobine kukuruza kokičara predstavlja veliki izazov u oplemenjivanju, jer je potrebno uskladiti zahteve tržišta i proizvođača koji imaju različite prioritete.

Ključne reči: kukuruz kokičar, prinos, zapremina kokičavosti, procenat neiskokanog zrna

Zahvalnica: Rad je rezultat istraživanja u okviru ugovora 451-03-47/2023-01/200040 od 17.01.2023. godine, finansiranog od strane Ministarstva nauke, tehnološkog razvoja i inovacija Republike Srbije.

CORRELATION BETWEEN YIELD AND POPPING VOLUME IN POPCORN HYBRIDS

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Popcorn is very popular snack food, and it poses valuable nutritive properties. It is also very attractive crop for producers and merchants. The most important trait of the popcorn is formation of the large fine „flake", produced under high temperature and pressure inside the kernel.Therefore equally important traits in popcorn are grain yield, popping volume and quality of the flake. Popping volume is influenced by genotype, as well as other factors such as: production and storage conditions, and popping methods. The influence of the stress factors such as drought, frost or diseases and mechanical damages of the grain at harvest and post-harvest treatments have significant impact on decrease in popping volume. Maximum popping volume could be obtained at the grain moisture of about 14 %. Lower moisture content does not provide enough pressure inside the grain necessary for exploding of pericarp and developing of starch granules. Nevertheless, higher moisture content also reduces popping volume. In this research 12 popcorn hybrids were sown in 2022 on two locations in threereplications. Following traits were analysed: grain yield, popping volume, and percentage of unpopped kernels. Average grain yield ranged from 4.42 t/ha (ZP622/1k) to 8.01 t/ha (ZP 615/2k). Popping volume of all hybrids was high ranging from 40 g/cm^3 to 46 g/cm^3. Rank correlation coefficient between grain yield and popping volume showed significant negative correlation r_s= -0,76**. Significant negative correlation between two most important traits in popcorn poses great challenge in popcorn breeding, and demands to coordinate between needs of producers, market and consumers, which don't have the same priorities. The percentage of unpopped kernels ranged from 0.5 % - 19.36%.

Key words: popcorn, grain yield, popping volume, percentage of unpopped kernels

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II-POS-42

PRIMENA ALTERNATIVNIH METODA ZAŠTITE USEVA U ODRŽIVOJ POLJOPRIVREDI

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Globalno zagrevanje, zagađenje životne sredine, gubitak biološke raznolikosti biljnih vrsta su pojave koje pokreću nove trendove i debate o ljudskom društvu. Održivi razvoj je novi koncept u svetu koji treba da zadovolji potrebe ljudskog društva uz očuvanje i unapređenje prirodnih resursa. Indikatori održivog razvoja su glavni alati u sprovođenju mera očuvanja prirodnih resursa. U poljoprivredi jedan od indikatora su štete nastale primenon sintetičkih sredstava. Primena novih tehnologija bez upotrebe hemijskih agenasa u zaštiti useva je mera koja treba da umanji nastale ekološke gubitke. Etarska ulja su jedan od najznačajniji prirodnih metabolita, sekundarni produkti aromatičnih biljaka koji se uspešno koriste kao biopesticidi. Biološka aktivnost etarskih ulja u poljoprivredi ima antimikrobno i herbicidno dejstvo. Efekti ulja zavise od pojedinačnih bioaktivnih komponenti. U prirodi igraju važnu ulogu u zaštita biljaka kao antibakterijski, antivirusni, antifungalni, insekticidni agensi. Kod većine korova, ulja kao tipični lipofili, prolaze kroz ćelijski zid citoplazmatske membrane, remete strukturu njihovih različitih slojeva polisaharida, masnih kiselina i fosfolipida i permeabiliziraju ih. Štete od primene eteričnih ulja (EU) na biljkama ogledaju se kroz hloroze, nekroze i inhibicije rasta. Značaj upotrebe ulja i drugih prirodnih metabolita ukazuje na njihovu upotrebnu vrednost u održivoj poljoprivredi iako fiziološka aktivnost ulja još uvek nije dovljno istražena.

Ključne reči: aromatične biljke, metaboliti, biološka aktivnost.

Zahvalnica: Rad je podržalo Ministarstvo nauke, tehnološkog razvoja i inovacija Republike Srbije, ugovor broj 451-03-9/2021-14/200040 i Evropska komisija kroz projekat TWINNING GREEN-EDITING VIBES FOR FΘΘD, broj 101059942.

APPLICATION OF ALTERNATIVE METHODS OF CROP PROTECTION IN SUSTAINABLE AGRICULTURE

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Environmental problems such as global warming, pollution, and the decline of plant species biodiversity are leading to new social trends and discussions. A relatively new idea of global sustainable development aims to meet societal demands while protecting and enhancing natural resources. The main tools used in the implementation of natural resource protection measures are sustainable development indicators. One of these indicators is the damage caused by the use of synthetic chemicals in agriculture. In Serbia, agriculture is an important sector of the economy with different levels of technological progress, from extensive to intensive. The degree of pollution and its impact on the environment varies according to agricultural production. The challenges faced by modern agricultural production in conditions of technological progress have led to the intensification of production, but have also caused concern about maintaining the natural balance of cultivated land and product quality. The application of innovative technologies for crop protection without the use of chemical agents is a step that should reduce the environmental damage caused. Among the most important natural metabolites and secondary products of aromatic plants used as biopesticides are essential oils. The biological activities of essential oils in agriculture have antimicrobial and herbicidal effects. The various bioactive components of the oil determine its action. In nature, they play an important role in protecting plants from bacteria, fungi, viruses and insects. In most weeds, the oils penetrate the cytoplasmic membrane of the cell as typical lipophiles and cause its multilayers of polysaccharides, fatty acids and phospholipids to lose their structure and become permeable. Chlorosis, necrosis, and growth inhibition are symptoms of damage caused by the application of essential oils to plants.

Although the physiological effects of the oil are not yet well studied, the importance of its use and other natural metabolites indicates its value for sustainable agriculture.

Key words: aromatic plants, metabolites, biological activity

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II-POS-43

PROCENA KOMBINACIONIH SPOSOBNOSTI ZA PRINOSA ZRNA KASNIH MUTANTNIH LINIJA KUKURUZA

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Opšte kombinacione sposobnosti (OKS) i posebne kombinacione sposobnosti (PKS) za prinos zrna devet kasnih mutantnih linija kukuruza procenjene su korišćenjem matematičkog modela Savčenka (1973). Linije su ukrštane u top-cross dizajnu sa 4 testera. Njihove hibridne kombinacije su testirane u poljskim ogledima korišćenjem standardne agrotehnike za to područje. Kao rezultat evaluacije ustanovljeno je da mutantna linija KSM 21-3-1*-1-1 ima najveće OKS, a zatim i linije KSM 26-4-2*-3-1, KSM 26-2-2* -1-1 i KSM 33-3-1*-2-1. Navedene linije se mogu koristiti kao komponente za stvaranje sintetika visokog potencijala rodnosti ili kao testeri u ukrštanjima za određivanje OKS u ranijim fazama procesa selekcije. Linije KSM 39-1-1-1-1, KSM 33-4-1*-1-1, KSM 21-3-1*-1-1, KSM 26-6-1-1-1 i KSM 33-3-1*-2-1, visokih PKS su pogodne za uključivanje u hibridne kombinacije u oplemenjivanju visokoprinosnih hibrida. Dve mutantne linije spektra, KSM 21-3-1*-1-1 i KSM 33-3-1*-2-1, poseduju istovremeno visoke opšte i posebne kombinacione sposobnosti. Mogu se koristiti na više načina u procesu oplemenjivanja.

Ključne reči: opšte kombinacione sposobnosti, posebne kombinacione sposobnost, *Zea mays* L.

EVALUATION OF THE COMBINING ABILITY FOR GRAIN YIELD OF LATE MUTANT MAIZE LINES

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The General Combining Ability (GCA) and Specific Combining Ability (SCA) for grain yield of nine late mutant maize lines were estimated using the mathematical model of Savchenko (1973). The lines were tested in a topcross design on 4 testers. Their hybrid combinations were tested in field trials using locally adopted agro-technical practice. As a result of the evaluation it was determined that the mutant line XM 21-3-1*-1-1 had the highest GCA, followed by XM 26-4-2*-3-1, XM 26-2-2*-1-1 and XM 33-3-1*-2-1. Those mutant lines could be used as components to create high-yielding synthetics or as testers in analyzing crosses to determine GCA at earlier stages of the selection process. The high SCA lines XM 39-1-1-1-1, XM 33-4-1*-1-1, XM 21-3-1*-1-1, XM 26-6-1-1-1 and XM 33-3-1*-2-1 are suitable for inclusion in crosses for developing high yielding hybrids. Two of the spectrum mutant lines, XM 21-3-1*-1-1 and XM 33-3-1*-2-1, possess both high GCA and high SCA, and could be of potential importance for different breeding purposes.

Key words: general combining ability, specific combining ability, *Zea mays* L.

II-POS-44

OPLEMENJIVANJE KUKURUZA U INSTITUTU ZA KUKURUZ - KNEŽA U USLOVIMA GLOBALNIH PROMENA I KLIMATSKOG STRESA

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Savremena proizvodnja zrna zahteva upotrebu visokoproduktivnih hibrida kukuruza koji su otporni na biotički i abiotički stres. Uspešni programi za stvaranje ovakvih hibrida u velikoj meri zavise od varijabilnosti polaznog materijala. Činjenica je da se u proizvodnji hibrida na svetskom nivou koristi relativno mali broj linija što nosi rizik od genetske erozije komercijalnh useva kukuruza. Stoga je od sve većeg značaja potreba za proširenje genofonda uz stvaranje i unapređenje novog izvornog početnog materijala za oplemenjivanje, što je skup i dugotrajan proces. Sa druge strane, praksa nameće zahteve da proces oplemenjivanja da brze rezultate. U pokušaju da se odgovori na date zahteve, u Institutu Kneža je stvorena nova sintetička populacija „1/2017" korišćenjem 16 inbred linija Instituta. Linije su nastale iz lokalnih populacija (zubana i poluzubana), sa visokim kapacitetom adaptacije, nastale kao rezultat eksperimentalne mutageneze hibrida proverenog kvaliteta. Sintetik je 2019. godine uključen u Nacionalni naučni program „*Healthy foods for a strong bioeconomy and quality of life*" Ministarstva prosvete i nauke (https://vvv.mon.bg/bg/58). Godišnje se radilo na površini od 8 ha, koja je obuhvatala test površine, oplemenjivačko polje i izolacije, do 2023. godine. Testirano je 505 eksperimentalnih hibrida koji su nastali kao rezultat unapređenja kroz oplemenjivanje, u okviru Radnog paketa 1.3. Odabrano je 87 linija koje su uključene u radnu kolekciju Instituta. Pored toga,13 perspektivnih hibrida kukuruza tolerantnih na sušu, srednje rane i srednje kasne grupe zrenja (FAO 400-500 i 500-600) je predloženo za ispitivanje u Izvršnoj agenciji za ispitivanje sorti, odobravanje i kontrolu semena. Kao krajnji rezultat četvorogodišnjeg rada datog programa, izdvojeno je sedam novih hibrida kukuruza: Kneža 565, Kneža 573, Kneža 575, Kneža 576, Kneža 650A, Kneža 651 i Kneža 652. Prva četiri hibrida pogodna su za zrno, odlikuju se visokim potencijalom rodnosti, otporni su na sušu i dobro otpuštaju vlagu. Preporučuju se za gajenje u svim regionima zemlje. Hibridi iz grupe preko FAO 600 su nova generacija genotipova otpornih na stres, koji se, pored visokog prinosa zrna uspešno mogu gajuti i za silažu. Za silažu su pogodni za sve regione, a za zrno preporučuju do 700 m nadmorske visine.

Ključne reči: genetička erozija, oplemenjivački program, *Zea mays* L.

MAIZE BREEDING AT THE MAIZE RESEARCH INSTITUTE - KNEZHA IN CONDITIONS OF GLOBAL CHANGES AND CLIMATE STRESS

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Contemporary grain production requires the use of highly productive maize hybrids which are biotic and abiotic stress resistant. Successful programmes for creating such hybrids to a great extent depend on variability of starting material. Having in mind a relatively small number of lines that has been worked with on a worldwide scale and the increasing danger of genetic erosion in maize, the significance of expanding the gene pool by creating and improving new source of breeding material is growing. Improvement through breeding is expensive and time consuming. Meanwhile, the practice imposes requirements to the breeding process for rapid results and commercial hybrids for immediate use. In response, a new synthetic population *"1/2017"* which merges 16 inbred lines from Maize Research Institute – Knezha has been created. The lines originate from local populations (Tooth-shaped and Hard Tooth-Shaped), with high adaptive capacity that results from experimental mutagenesis in hybrids with proven qualities. In 2019 the synthetic has been included in The National Scientific Program "Healthy foods for a strong bioeconomy and quality of life" of the Ministry of Education and Science - https://www.mon.bg/bg/58. Experimental field yearly encompassed an area of 8 ha, and included breeding and isolation fields, until 2023. 505 experimental hybrids have been tested as a result of improved breeding, provided in Work Package 1.3. 87 self-pollinated lines have been selected to present the Institute's work collection. 13 perspective, drought-resistant, stress-tolerable maize hybrids from mid-early and mid-late maturity group (FAO 400-500 and 500-600) have been created and proposed for testing in Executive Agency For Variety Testing, Approval and Seed Control. During 4 years of work under the program, 7 new maize hybrids were recognized - Knezha 565, Knezha 573, Knezha 575, Knezha 576, Knezha 650A, Knezha 651 and Knezha 652. The first four hybrids are suitable for grain production, are drought resistant, realize high yield with standard moisture and are recommended for cultivation in all regions of the country. Hybrids from group over FAO 600 are a new generation of stress-tolerant genotypes, which, in addition to high yield potential, are characterised by excellent silage indicators and green mass qualities. Silage types are suitable for all regions of the country, while for grain are recommended in regions up to 700 m. altitude.

Key words: genetic erosion, breeding programme, *Zea mays* L.

II-POS-45

RAZVOJ, FIZIOLOGIJA I ANATOMIJA NODULA NA KORENU SOJE

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Izuzetan ekološki i privredni značaj soje je što kao biljka azotofiksator ima sposobnost prevođenja atmosferskog azota u amonijačni oblik dostupan biljkama. Proces se odvija na korenu soje u nodulama koje nastaju u simbiozi biljke i bakterija iz roda *Bradhyrhizobium japonicum.* Kontakt između biljke i bakterija počinje izlučivanjem u zemljište raznih vrsta polifenola (izoflavona), signalnih jedinjenja koja privlače bakterije. Nakon difuzije izoflavona kroz bakterijsku membranu dolazi do pokretanja Nod faktora bakterije, tj. lipohitooligosaharida pomoću kojih bakterija vrši infekciju korenske dlake. Nakon infekcije započinje obrazovanje azotofiksirajuće nodule u kojoj su svi metabolitički procesi pod potpunom kontrolom biljke. Biološku fiksaciju u noduli vrši enzim nitogenaza u anaerobnim uslovima. Biljka i bakterija zajedno stvaraju jedinjenje leghemoglobin koje vezuje kisonik i omogućava stvaranje anaerobnih uslova koji pogoduju enzimu nitrogenazi vršenje procesa azotofiksacije. Takođe, leghemoglobin aktivnoj noduli daje crvenu boju na poprečnom preseku. Anatomska građa aktivne nodule predstavljena je strukturno sa tri različite zone. Najveću zonu čini centralni deo, tj. tkivo inficirano bakterijama (rizobijum polje), a na njega se naslanja unutrašnja kora (korteks) i spoljašnja kora (eksterni korteks). Prve nodule počinju da vrše azotofiksaciju u fazi razvoja soje „dve troliske"(V2) ili „tri roliske"(V3), da bi najveći broj aktivnih nodula bio u fenofazi „početak formiranja semena" (R5). Prosečna aktivnost nodula traje 30-40 dana. O ovim procesima postoji dosta naučnih saznanja, međutim i dalje postoji dosta prostora za rasvetljavanje odnosa biljka soje i bakterija *Bradhyrhizobium japonicum*, a sve u funkciji dobrobiti koje oni donose poljoprivrednoj proizvodnji.

Ključne reči: soja, nodule, izoflavoni, azotofiksacija, *Bradhyrhizobium japonicum*

DEVELOPMENT, PHYSIOLOGY AND ANATOMY OF SOYBEAN ROOT NODLES

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The exceptional ecological and economic importance of soybeans is that, as a nitrogen-fixing plant, it has the ability to convert atmospheric nitrogen into an ammonia form available to plants. The process takes place on soybean roots in nodules that are formed in the symbiosis of the plant and bacteria from the genus *Bradhyrhizobium japonicum*. The contact between the plant and the bacteria begins with the excretion into the soil of various types of polyphenols (isoflavones), signal compounds that attract the bacteria. After the diffusion of isoflavones through the bacterial membrane, the Nod factor of the bacteria is activated, i.e. of lipochitooligosaccharides with which the bacterium infects the root hair. After infection, the formation of a nitrogen-fixing nodule begins, in which all metabolic processes are under the complete control of the plant. Biological fixation in the nodule is carried out by the enzyme nitrogenase under anaerobic conditions. Together, the plant and the bacteria create the compound leghemoglobin, which binds oxygen and enables the creation of anaerobic conditions that favor the nitrogenase enzyme for the nitrogen fixation process. Also, leghemoglobin gives the active nodule a red color on cross-section. The anatomical structure of the active nodule is represented structurally by three different zones. The largest zone is the central part, i.e. tissue infected with bacteria (rhizobium field), and the inner bark (cortex) and the outer bark (external cortex) rest on it. The first nodules begin to carry out nitrogen fixation in the stage of soybean development "two trefoils" (V2) or "three trefoils" (V3), so that the largest number of active nodules would be in the phenophase "the beginning of seed formation" (R5). Average nodule activity lasts 30 to 40 days. There is a lot of scientific knowledge about these processes, but there is still a lot of room for improvement elucidating the relationship between the soybean plant and bacteria *Bradhyrhizobium japonicum*, all in function of the benefits they bring to agricultural production.

Key words:soybean, nodul, isoflavones, nitrogen fixation, *Bradhyrhizobium japonicum*

II-POS-46

PRODUKTIVNOST SOJE I MOGUĆNOST KORIŠĆENJA KAO ENERGENTA

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Žetveni ostaci suncokreta, kukuruza, uljane repice i soje čine više od 50 odsto ukupnog prinosa biomase i mogu se koristiti i za dobijanje bioenergije. Kao izvoru bioenergije prednost se daje žetvenim ostacima koji sadrže više celuloze i ulja, kao što je na primer slama soje. Oplemenjivanje soje ima za cilj stvaranje sorti sa većom biomasom i povećanim prinosom ulja po hektaru, kao i stvaranje sorti koje bi više odgovarale industrijskoj preradi za proizvodnju tehničkih ulja. U ovoj studiji ispitivani su produktivni parametri soje u dvogodišnjem periodu, 2021.i 2022. Prosečni prinosi soje su varirali od 2,8 t ha^{-1} (2022), do 2,9 t ha^{-1} (2021). Ukupni prinosi biomase soje iznosili su 4,75 t ha^{-1}, dok je prinos biogasa iznosio 384,5 m^3 ha^{-1}. Godina je imala značajan uticaj na proizvodnju soje. Povoljnija godina za proizvodnju bila je 2021. sa značajno većim prinosima zrna, biomase i biogasa u odnosu na 2022.

Ključne reči: soja, produktivnost, prinos zrna, prinos biomase, prinos biogasa

PRODUCTIVITY OF SOYBEAN AND THE POSSIBILITY OF USING IT AS ENERGY

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Harvest residues of sunflower, maize, oilseed rape and soybeans make up more than 50% of the total biomass yield and can also be used to obtain bioenergy. As a source of bioenergy, preference is given to harvesting residues that contain more cellulose and oil, such as soybean straw. Soybean breeding aims to create varieties with higher biomass and increased oil yield per hectare, as well as to create varieties that would be more suitable for industrial processing for the production of technical oils. In this study, the productive parameters of soybeans were investigated in two years, 2021 and 2022. The average yields of soybeans varied from 2.8 t ha^{-1}(2022) to 2.9 t ha^{-1} (2022). The total soybean biomass yield was 4.8 t ha^{-1}, while the biogas yield was 384.5 m^3 ha^{-1}. The year had a significant impact on soybean production. The more favourable year for production was 2021, with significantly higher yields of grain, biomass and biogas, compared to 2022.

Key words: biogas yield, biomass yield, grain yield, productivity, soybean

II-POS-47

GENETIČKI ODGOVOR LUCERKE NA TOKSIČNO DELOVANJE JONA ALUMINIJUMA NA KISELOJ HIDROPONSKOJ KULTURI

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Toksičan efekat aluminijuma veoma je važan faktor koji ograničava rast i razviće korena lucerke (*Medicago sativa* L.) na kiselim zemljištima što dovodi do smanjenja prinosa. Cilj eksperimenta bio je da se utvrdi uticaj aluminijuma na: dužinu korena, svežu nadzemnu masu, svežu masu korena, broj bočnih korenova, dužinu bočnih korenova i na rastojanje do prvog bočnog grananja na korenu kod klijanaca tri sorte lucerke (Zuzana, K-28, O-66) u hidroponskoj kulturi u kontrolisanim uslovima. Korišćen je Hoaglandov rastvor ½ jačine pH vrednosti 4.5, za tretman je korišćen aluminijum u formi aluminijum-hlorida (koncentracije 100 μM) i za analize je korišćeno 40 klijanaca po sorti. Dvofaktorijalnom analizom varijanse utvrđeni su pojedinačni uticaji sorte i aluminijuma, kao i interakcijski odnosi između sorti i aluminijuma kod svih parametara osim dužine korena i sveže nadzemne mase. Za svežu nadzemnu masu kontrola se razlikovala od tretmana aluminijumom, ali su se i sorte značajno razlikovale među sobom. Sveža masa korena je smanjena 74,47% kod tretmana u odnosu na kontrolu, ali nije bilo značajne razlike između sorti u okviru tretmana. Aluminijum je imao uticaja na broj bočnih korenova tako da su se sorte razlikovale u kontroli i tretmanu. Za rastojanje do prvog bočnog korena postojale su razlike između kontrole i tretmana, dok se sorte Zuzana i K-28 nisu razlikovale među sobom ali se jesu razlikovale od O-66. Dužina korena se kod svih sorti značajno smanjila kod tretmana aluminijumom u odnosu na kontrolu. Sorta sa najstabilnijim prinosom i svežom masom korena u uslovima toksičnosti aluminijuma je O-66.

Ključne reči: lucerka, toksičnost aluminijuma, hidroponska kultura.

Zahvalnica: Ovo istraživanje podržano je od strane Ministarstva prosvete, nauke i tehnološkog razvoja Republike Srbije; broj ugovora 451-03-47/2023-01/200217 and 451-03-47/2023-01/200168.

GENETIC RESPONSE OF ALFALFA TO THE TOXIC EFFECT OF ALUMINUM IONS ON ACID HYDROPONIC CULTURE

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The toxic effect of aluminum is a very important factor that limits the growth and development of alfalfa (*Medicago sativa* L.) roots on acidic soils, which leads to a yield decrease. The aim of the experiment was to determine the effect of aluminium on root lenght, fresh root weight, fresh shoot weight, number of lateral roots, lenght of lateral roots and distance to first lateral branching on the tap root in seedlings of three cultivar of alfalfa (Zuzana, K-28, O-66) in hydroponic culture under controlled conditions. The ½-strenght Hoagland's nutrient solution (pH 4.5), aluminium in the form of aluminium-chloride (concentration 100 μM) and 40 seedlings per cultivar was used for the experiment. The two-factor analysis of variance determined the individual effects of cultivar and aluminium, as well as the interactions between cultivars and aluminium for all parameters except root lenght and fresh shoot weight. For the fresh shoot weight the control distinguished from the aluminium treatment and the cultivars also differed significantly among themselves. Fresh root weight was reduced by 74.47% in treatment compared to control but there wasn't significant difference between the cultivars within the aluminium treatment. Aluminium had an impact on the number of lateral roots in the way that tested cultivars showed differences in control and treatment. Conserning the distance to first lateral branching on the tap root, the values showed differences between control and treatment, while cultivars Zuzana and K-28 did not differ from each other but they did differ from O-66. The root lenght of all cultivars significantly reduced in the aluminium treatment compared to control. Cultivar with the most stable yield and fresh root mass under conditions of aluminum toxicity is O-66.

Key words: alfalfa, aluminium toxicity, hidroponic culture.

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II-POS-48

PRISUSTVO AKTIVNIH MATERIJA U GRAHORICI

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Grahorica (*Vicia sativa* spp.) se može koristiti u ljudskoj ishrani jer, pored visokog sadržaja proteina i drugih hranljivih materija, može imati i zdravstvene koristi. Međutim, u grahorici se nalaze jedinjenja poznata kao antinutritivni faktori (NNF – non-nutrient factors) koji mogu smanjiti iskoristljivost ostalih hranljivih materija i negativno uticati na zdravlje. Sa druge strane, NNF, u određenoj koncentraciji, mogu imati određene zdravstvene prednosti jer omogućavaju bioraspoloživost esencijalnih minerala i pozitivno utiču na biohemijske procese u organizmu. Novija istraživanja su fokusirana na ispitivanje koncentracije ovih materija koje bi omogućile ravnotežu između korisnih i štetnih efekata, da bi se dobila poželjna interakcija sa drugim komponentama ishrane. Dvogodišnji poljski ogled (2021. i 2022.), sa 11 genotipova obične grahorice, postavljen je po slučajnom blok sistemu u uslovima standardne agrotehnike na oglednom polju Instituta za krmno bilje Kruševac. Analiziran je ekstrakt cele biljke u fazi mlečne zrelosti zrna i ekstrakt zrelog zrna. Ispitivana je količina ukupnih fenola, flavonoida i kondenzovanih tanina u ekstraktu. U ekstraktu cele biljke, ispoljena je velika varijabilnost između ispitivanih genotipova: ukupni fenoli od 2,77 do 23,53 g GAE/100g; flavonoidi od 2,14 do 9,90 gCAE/100g; kondenzovani tanini od 316,2 do 730 mgCAE/100g. Količina ispitivanih supstanci bila je značajno veća u ekstraktu zrelog zrna nego u ekstraktu cele biljke. Utvrđena je izvesna povezanost u sadržaju ispitivanih supstanci: visok sadržaj jedne, značio je visok sadržaj i ostale dve. U ekstraktu zrelog zrna sadržaj svih ispitivanih materija (ukupni fenoli, flavonoidi i kondenzovani tanini) je bio najveći kod genotipa 1A, a najniži kod genotipa 21A.

Ključne reči: obična grahorica, ukupni fenoli, flavonoidi,kondenzovani tanini

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THE PRESENCE OF ACTIVE SUBSTANCES IN VETCH

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Vetch (*Vicia sativa* spp.) can be utilized in human nutrition since it has health benefits in addition to being high in protein and other nutrients. However, vetch includes non-nutritive factors (NNF), which might impair the consumption of other nutrients and have a negative impact on health. NNF, on the other hand, can have health benefits in specific concentrations because they increase the bioavailability of important minerals and have a good effect on biochemical processes in the human body. Recent study has concentrated on determining the concentration of these compounds that would allow for a balance of positive and negative effects, in order to achieve a desired interaction with other food components. On the experimental field of the Institute for Forage Crops Kruševac, a two-year field experiment with 11 genotypes of common vetch was set up using a random block method under conventional agrotechnical circumstances. The extracts of the whole plant at the stage of milky grain maturity and mature grain were studied. The total phenols, flavonoids, and condensed tannins in the extract were measured. Total phenols ranged from 2.77 to 23.53 gGAE/100g, flavonoids ranged from 2.14 to 9.90 gCAE/100g, and condensed tannins ranged from 316.2 to 730 mgCAE/100g in the extract of the whole plant. The amount of investigated compounds was much higher in the ripe grain extract than in the entire plant extract. A link was discovered in the content of the tested substances in ripe grain: a high content of one suggested a high content of the other two.

Key words: common vetch, total phenols, flavonoids, condensed tannins

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II-POS-49

PRIMENA AMMI MODELA U SELEKCIJI DVOREDIH JEČMOVA

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Interakcija genotipa i spoljašnje sredine (GEI) je kompleksan problem koji komplikuje proces selekcije i oplemenjivanja ratarskih kultura te je stoga važno utvrditi njenu značajnost i iskoristiti njene pozitivne karakteristike. U radu je analiziran prinos zrna dvadeset genotipova ozimog dvoredog ječma u šest spoljašnjih sredina (dve vegetacione sezone na tri lokaliteta). Za analizu interakcije korišćen je linearni mešoviti model i model glavnih efekata i višestruke interakcije (AMMI) sa AMMI1 biplot prikazom. Utvrđena je visoka statistička značajnost interakcije dok je AMMI1 model objasnio 40.1% varijacije interakcije. Stabilnost genotipova određena je parametrima stabilnosti AMMI modela (AMMI1, AMMI2 i ASV) i utvrđena je značajna korelacija rangova genotipova između njih. Prinos nije pokazao značajnu korelaciju ni sa jednim parametrom. Na osnovu Genotip Selekcionog Indeksa (GSI), genotipovi J-82, J-103, NS-589 i J-176 su izdvojeni kao široko adaptabilni i superiorni u pogledu prinosa i stabilnosti što je potvrđeno i biplot prikazom. Genotipovi koji su na osnovu AMMI1 procenjenih vrednosti prinosa preporučeni za svaki od lokaliteta su najprinosniji NS-525, NS-593, J-176, NS-589, J-103 i J-82. Razlike u interakcijskom efektu između godina (Zemun Polje i Zaječar) kao i slab diskriminatorski efekat (Kragujevac) ne izdvajaju ni jedan lokalitet kao pogodnu test lokaciju. Winner pristupom, sve ispitivane sredine možemo smatrati kao jednu mega-sredinu što ukazuje da u ogledu dominiraju nepredvidive interakcije što specifične adaptacije čini manje značajnim. AMMI1 model je pouzdan i informativan u interpretaciji interakcije i ništa se značajno neće promeniti ako se druga interakcijska komponenta naknadno uključi. Izdvojene su neke inbred linije ječma što ovaj model čini pogodnim u selekciji perspektivnih genotipova.

Ključne reči: dvoredi ječam, prinos zrna, multivarijaciona analiza, stabilnost, adaptabilnost.

Zahvalnica: Rad je nastao kao rezultat projekta TR 31054, finansiranog od strane Ministarstva prosvete, nauke i tehnološkog razvoja Republike Srbije

APPLICATION OF AMMI MODEL IN THE SELECTION OF TWO-ROW BARLEY

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Genotype by environment interaction (GEI) is a complex problem which complicates the selection and breeding process of field crops, and therefore it is important to determine the significance and take advantage of GEI. The paper analyzed the grain yield of twenty genotypes of winter two-row barley in six environments (two growing seasons in three localities). A linear mixed model and additive main effects and multiplicative interaction (AMMI) model with AMMI1 biplot display were used for interaction analysis. High statistical significance GEI was determined and AMMI1 model was explain 47% of interaction. The stability of the genotypes was estimated by different AMMI stability parameters (AMMI1, AMMI2 and ASV) and a significant correlation was established between them. Grain yield and stability were not related. Genotypes J-82, J-103, NS-589 and J-176 were selected as superior and wide adaptability using Genotype Selection Index (GSI). They highlight as stable and high yielding which was agreement with results of biplot analysis. On based AMMI1 estimates of grain yield, the genotypes recommended in each of the localities were the most yielding NS-525, NS-593, J-176, NS-589, J-103and J-82. The difference in the interaction effect by year (Zemun Polje and Zaječar) and weak discriminating effect (Kragujevac) does not sepatare any suitable test location. By winner approach, all the examined environments can be considered as one mega-environment, which indicates that unpredictable interactions dominate in this research, due to which specific adaptations were not of high importance. AMMI1 model is reliable and informative in the interpretation of the GEI which indicates that essentially nothing happens when the second interaction axis is subsequently included. Some inbred lines of barley have stood out, which makes this model suitable for the selection of perspective genotypes.

Key words: two-row barley, grain yield, multivariate analysis, stability, adaptability.

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II-POS-50

UTICAJ SPOLJNE SREDINE NA KVALITET ZRNA PŠENICE

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Pšenica (*Triticum* spp.) je jedna od najadaptabilnijih biljnih vrsta, zbog sposobnosti da se prilagodi variranju uslova spoljne sredine. Međutim, visoke temperature, količina i raspored padavina tokom rasta i razvića biljke i nalivanja zrna utiču na fiziološko-biohemijske procese, a time i na kvalitet zrna pšenice. Visoka tehnologija gajenja poljoprivrednih useva smanjuje negativan uticaj meteoroloških uslova. Sa druge strane, tehnološki razvoj i intenzivirana poljoprivredna proizvodnja uzrokuju globalne klimatske promene. Cilj ovog rada bio je da se analizira uticaj abiotskih faktora (minimalna, maksimalna i srednja temperatura vazduha i suma padavina) na kvalitet zrna ozime pšenice. Analizirano je dvadeset sorti ozime pšenice, domaćeg i stranog porekla, tokom dve vegetacione sezone (2021/2022 i 2022/2023) Istraživanja su izvedena na oglednom polju (Rimski šančevi) i u laboratoriji Instituta za ratarstvo i povrtarstvo, Novi Sad, Srbija. Analizirani su parametri tehnološkog kvaliteta pšenice: sadržaj proteina, vlažni gluten i sedimentacija. Utvrđena je pozitivna statistički značajna korelacija između parametara kvaliteta, sadržaja proteina i sedimentacione vrednosti (r=0,6173). Sadržaj vlažnog glutena nije bio u statistički značajnoj korelaciji ni sa jednim od gore navedenih parametara kvaliteta. Nisu dobijene statističke značajne razlike između dve ispitivane vegetacione sezone. Jednovarijantna ANOVA analiza je pokazala da je sorta MV Magdalena imala statistički najvišu vrednost vlažnog glutena od svih ispitivanih sorti. Ovi rezultati ukazuju da je za razliku od abiotskih faktora u ispitivanim uslovima, sorta imala značajan uticaj na ispitivane parametre kvaliteta pšenice. Dalja istraživanja u oplemenjivanju pšenice treba da idu u pravcu stvaranja sorti sa stabilnim i dobrim osobinama tehnološkog kvaliteta u uslovima globalnih klimatskih promena.

Ključne reči: pšenica, kvalitet, klimatski faktori, korelacija

EFFECT OF THE ENVIRONMENT ON WHEAT GRAIN QUALITY

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Wheat (*Triticum* spp.) is one of the most adaptable crop species due to its ability to adjust to the variations of the environmental factors. However, high temperatures, precipitation quantity and distribution during plant development and grain filling affect biochemical processes and consequently grain quality. Advanced technology in growing agricultural crops decreases the negative impact of meteorological conditions. On the other hand, increased technological development and intensified agricultural production cause global climate change. The aim of this study was to analyze the effect of abiotic factors (minimum, maximum and optimum average temperature and precipitation sum) on the quality of winter wheat grain. Twenty national and international winter wheat cultivars were analyzed in two growing seasons. The trial was carried out on the experimental fields and in laboratories of the Institute of Field and Vegetable Crops. The following wheat quality parameters were analyzed: protein content, wet gluten and sedimentation. A significant positive correlation was found between protein content and sedimentation value (r=0.6173). Wet gluten content was not significantly correlated with either of the parameters. There were no significant differences between the two growing seasons. Univariate ANOVA analysis showed that the cultivar MV Magdalena statistically had the highest value of wet gluten of all the cultivars. The results showed that cultivar had a significant effect on the tested wheat quality parameters, unlike abiotic factors in the trial conditions. Further research in wheat breeding should be directed towards developing cultivars with stable and good characteristics of technological quality under the conditions of global climate change.

Key words: wheat, quality, climate factors, correlations

II-POS-51

SVOJSTVA HELJDE I UTICAJ SKLADIŠTENJA NA STANJE ZRNA

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Skladištenje heljde je značajan faktor koji moze uticati na svojstva zrna sto je bio predmet istraživanja i to primenom tretmana veštačkog starenja u cilju ubrzavanja procesa. Ispitivani su klijavost semena, fizička svojstva (masa 1000 zrna, hektolitarska masa i dimenzije zrna) i hemijski parametri (pH vrednost, ukupna alkoholna kiselost, sadržaj vode, nivo proteina, sadržaj ukupnih lipida i pepela). Za ovu studiju poljski ogled je postavljen na zemljistu tipa smonica, po slučajnom blok sistemu u 3 ponavljanja sa veličinom parcela 120m^2 tokom proizvodne 2021. i 2022. godine u Topoli. Proizvodnu 2022. godinu obeležili su nepovoljni uslovi za proizvodnju heljde što se negativno odrazilo na prinos i ostale osobine heljde posebno na klijavost zrna. Agrohemijskom analiom osnovnih parametara plodnosti ustanovljeno je da je zemljište slabo kisele reakcije, (pH u KCl =6,0), slabo humusno (2,40 %), srednje obezbeđeno azotom (0,09 %), sa vrlo niskim nivoom lakopristupačnog fosfora (1,31 mg/100g zemljišta) i optimalnim sadržajem kalijuma (15,7 mg/100g zemljišta). Prosečan prinos heljde bio je 1,86 t ha^{-1}. Nakon 3 meseca skladištenja klijavost je smanjena za 6,6% ali bez statistički značajne razlike. Masa 1000 zrna smanjena je za 0,20 g (0,81%) što je ustanovljeno i kod ostalih fizičkih svojstava ali bez statistički značajnih razlika. Dužina zrna se smanjila za 0,37%, širina za 0,22% i debljina za 0,59%. Ispitani parametri hemijskih svojstava opadaju tokom vremena skladištenja, sa izuzetkom za sadržaj pepela čija vrednost raste. Statistički značajne razlike su uočene u sadržaju vlage i pepela. Sadržaj vlage je smanjen sa 10,21% na 9,09%, dok je sadržaj pepela povećan za oko 1,3 puta. Sadržaj proteina se značajno smanjio sa 12,1 na 11,46%, a lipida sa 3,09 na 2,78%. Smanjenje sadržaja vode je očekivano jer su uzorci izloženi povišenoj temperature, dok je sadržaj mineralnih materija povećan. Vrednosti pH i ukupne alkoholne kiselosti su smanjene (pH= 6,74 na 6,63; Ukupna alkoholna kiselost 1,35 na 1,18).

Ključne reči: heljda, skladištenje, fizička svojstva, kvalitet

Zahvalnica: Rad je nastao kao rezultat istraživanja u okviru ugovora o realizaciji i finansiranju naučnoistraživačkog rada u 2023. godini između Instituta za primenu nauke u poljoprivredi i Poljoprivrednog fakulteta Beograd sa Ministarstvom nauke, tehnološkog razvoja i inovacija Republike Srbije, evidencioni broj ugovora: 451-03-47/2023-01/200045 i 200116.

PRODUCTIVE PROPERTIES OF BUCKWHEAT AND THE EFFECT OF STORAGE ON KERNEL CONDITIONS

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In this study, to assess change in quality of stored buckwheat kernels, artificial aging was applied to speed up the processes. The researchers studied germination, physical properties (1,000 kernel weight, hectoliter weight and kernel size) and chemical properties of buckwheat (pH level, total alcoholic acidity, water level, protein level, total lipid and ash. The field trial was set up on a vertisol, in a randomized block design in three replication, with 120 m^2 plots in Topola during 2021 and 2022. In 2022, conditions for buckwheat production were rather adverse, negatively affecting yields and other properties, especially kernel germination. Agrochemical testing on basic fertility parameters showed that the soil was mildly acidic (pH in KCl was 6,0), moderately supplied with humus (2,40 %), moderately supplied with nitrogen (0,09 %), with very low levels of easily approachable phosphorous (1,31 mg/100g soil) and optimal levels of potassium (15,7 mg/100g soil). The average yield was 1,86 t ha^{-1}. After three months of storage, the germination decreased by 6,6%, but no statistically significant difference was detected. The thousand kernel weight also decreased by 0,20 g (0,81%), as well as other physical properties, also with no statistically significant differences detected. The kernel length decreased by 0,37%, kernel width by 0,22% and thickness by 0,59%. The investigated chemical parameters also decreased over time of storage, except for the ash level that increased. There were statistically significant differences between the moisture levels and ash levels. The moisture level decreased from 10,21% to 9,09%, unlike the ash level that has a 1,3-fold increase. The protein level significantly decreased from 12,1 to 11,46%, and lipids from 3,09 to 2,78%. A decrease in water levels was expected since the specimens were exposed to higher temperatures and the level of mineral matter increased. The levels of pH and total alcoholic acidity both decreased (pH from 6,74 to 6,63; total alcoholic acidity from 1,35 to 1,18).

Key words: Buckwheat, storage, physical properties, quality

II-POS-52

ANALIZA POTENCIJALA I STABILNOSTI OSOBINA KVALITETA KG LINIJA PŠENICE

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Izražene klimatske promene predstavljaju ograničavajući faktor biljne proizvodnje. Negativni efekti tih promena dovode do promena u kvalitetu zrna pšenice, usled čega ne dolazi do ispoljavanja genetskog potencijala sorti. Cilj ovog istraživanja je da se ispita potencijal i stabilnost kvaliteta zrna genotipova pšenice, selekcionisanih u Centru za strna žita i razvoj sela Kragujevac. Kao materijal istraživanja korišćeno je 13 perspektivnih genotipova ozime pšenice stvorenih u Kragujevcu i jedna standardna sorta, Pobeda. Poljski ogledi su izvedeni u tokom 2013/2014. i 2014/2015. na tri lokaliteta: Centar za strna žita i razvoj sela u Kragujevcu, Institut za krmno bilje u Kruševcu i Agroinstitut u Somboru. Ogled je postavljen po potpuno slučajnom blok sistemu, u tri ponavljanja sa veličinom osnovne parcelice od 5 m^2. Nakon žetve, analizirani su sedimentaciona vrednost i sadržaj vlažnog glutena. Prvu eksprimentalnu godinu odlikovala je izuzetno velika količina padavina na sva tri lokaliteta tokom fenofaze klasanje i nalivanje zrna, što je negativno uticalo na kvalitet zrna analiziranih genotipova pšenice. Kao najstabilniji genotipovi za sedimentaciju proteina, sa iznad prosečnim vrednostima, izdvojili su se KG-52/23 i KG-1/6 (33,89 ml; 34,94 ml) i KG-27/6 za sadržaj vlažnog glutena (31,36 %). Genotip KG-52/3, koji je imao visoke interakcijske vrednosti, ostvario je i najveće prosečne vrednosti za obe analizirane osobine kvaliteta zrna. Interakcije genotipa i spoljne sredine je imala najveće učešće u ukupnoj varijaciji za sedimentaciju proteina, dok spoljnoj sredini pripada najveći deo sume kvadrata za sadržaj vlažnog glutena.

Ključne reči: pšenica, kvalitet zrna, stabilnost, AMMI

Zahvalnica: Istraživanja u ovom radu su deo ugovora br. 451-03-68/2022-14/200216, finansiranog od strane Ministarstva nauke, tehnološkog razvoja i inovacija Republike Srbije.

ANALYSIS OF POTENTIAL AND STABILITY CHARACTERISTICS OF KG WHEAT LINES

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Pronounced climate changes are a limiting factor in plant production. The negative effects of those changes, lead to changes in the wheat grains quality, as a result of which the genetic potential of the varieties is not manifested. The goal of this research was to examine the potential and stability of grain quality of wheat genotypes selected at the Centre for Small Grains and Rural Development Kragujevac. As research material, 13 perspective winter wheat genotypes created in Kragujevac and check variety Pobeda were used. Field trials were conducted during 2013/2014 and 2014/2015 in localities: Centre Kragujevac, Institute for Forage Crops Kruševac and Agroinstitute Sombor. The experiment was set up according to a completely random block system, in three replications with a basic plot size of 5 m^2. After the harvest, sedimentation value and wet gluten content were analyzed. The first experimental year was distinguished by an extremely high amount of precipitation in all three localities during the ear development and grain feeling phenophases, which negatively affected the quality of the grains of the wheat genotypes analyzed. Genotype KG-52/23 stood out as the most stable for protein sedimentation (33.89 ml; 34.94 ml) and KG-27/6 for wet gluten content (31.36 %). Genotype KG-52/3, which had high interaction values, achieved the highest average values of both analyzed grain quality traits. Interaction genotype-environment had the largest part in the total variation for protein sedimentation, while the largest part of the sum of squares for wet gluten content belongs to the environment.

Key words: wheat, grain quality, stability, AMMI

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II-POS-53

AGRONOMSKA SVOJSTVA PERSPEKTIVNIH LINIJA PŠENICE

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Osnovni cilj oplemenjivanja je stvaranje novih sorti biljaka, sa visokim genetičkim potencijalom za prinos, koje bi najbolje odgovarale pojedinim regionima, heterogenim u pogledu klime i zemljišta. Na oglednom polju Centra za strna žita u Kragujevcu tokom dve vegetacione sezone 2018/19. i 2019/20. analiziran je prinos zrna, visina biljke, otpornost na poleganje i masa 1 000 zrna 10 perspektivnih genotipova (homozigotnih linija) ozime pšenice. Pored agronomskih osobina u poljskim uslovima na osnovu tipova infekcije, inteziteta zaraze i izračunavanjem koeficijenta infekcije, ocenjena je otpornost genotipova prema lisnoj rđi i sivoj pegavosti lista. Dobijeni podaci obrađeni su metodom analize varijanse faktorijalnog ogleda, a značajnost razlika testirana je LSD testom. Srednja godišnja temperatura i količina padavina u obe vegetacione sezone bile su iznad višegodišnjeg proseka. Saglasno po godinama, genotipovi pšenice su se razlikovali u analiziranim svojstvima. Značajno veći prinos zrna (6585 kg ha^{-1}), dobru otpornost na lisnu rđu i poleganje u obe vegetacione sezone imao genotip L5/9. U prvoj vegetacionoj sezoni zabeležene su nešto veće vrednosti mase 1000 zrna kao i visine biljke. Svi genotipovi su imali dobru otpornost na poleganje. Prosečan intezitet zaraze lisne rđe u 2019.godini bio je 17%, a u 2020. godini 16,5%, dok je prosečan intezitet zaraze sive pegavosti lista u 2019. godini iznosio 6%, a u 2020. godini 8%. Genotipovi koji su u istraživanju ocenjeni kao vrlo otporni mogu biti korišćeni kao izvori germ plazme u jačanju i stabilizaciji genetske zaštite genotipova pšenice.

Ključne reči: lisna rđa, poleganje, prinos zrna, pšenica

Zahvalnica: Istraživanja u ovom radu deo su projekta br. 451-03-47/2023-01/200088 koji finansira Ministarstvo nauke, tehnološkog razvoja i inovacija Republike Srbije.

AGRONOMIC TRAITS OF PROSPECTIVE WHEAT LINES

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Breeding aims to develop new plant varieties with high genetic potential for yield that would best suit specific regions characterized by climate and soil heterogeneity. In the field of the Small Grains Research Center in Kragujevac, during the two growing seasons of 2018/19 and 2019/20, grain yield, plant height, lodging resistance, and 1,000-grain weight were analyzed for 10 prospective genotypes (homozygous lines) of winter wheat. In addition to agronomic traits in field conditions, the genotypes' resistance to leaf rust and grey leaf spot were evaluated based on infection types, infection intensity, and infection coefficient calculation. The obtained data were processed using factorial analysis of variance, and the significance of differences was tested using the LSD test. The average annual temperature and precipitation in both growing seasons were above the long-term average. Across the years, wheat genotypes exhibited variations in the analyzed traits. Genotype L5/9 had significantly higher grain yield (6,585 kg ha^{-1}), and good resistance to leaf rust and lodging in both growing seasons. In the first growing season, slightly higher values of the of 1,000-grains weight as well as the height of the plants were recorded.. All genotypes exhibited good lodging resistance. The average leaf rust infection intensity was 17% in 2019 and 16.5% in 2020, while the moderate grey leaf spot infection intensity was 6% in 2019 and 8% in 2020. Genotypes identified as highly resistant in the study can serve as germplasm sources to enhance and stabilize the genetic protection of wheat genotypes.

Key words: grain yield, leaf rust, lodging, wheat

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II-POS-54

UTICAJ GENOTIPA PŠENICE NA FUNKCIONALNA SVOJSTVA INTEGRALNOG BRAŠNA

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Integralno pšenično brašno dobijeno mlevenjem celog zrna predstavlja bogat izvor hranljivih materija, prehrambenih vlakana, kompleksnih ugljenih hidrata, proteina, vitamina B grupe, minerala, kao i antioksidanata koji igraju važnu ulogu u prevenciji karcinoma i kardiovaskularnih bolesti. Normalni pšenični skrob se sastoji u proseku od 22–35% amiloze, dok voštani skrob sadrži oko 100% amilopektina. Različiti odnos osnovnih komponenata skroba, amiloze i amilopektina, kao i struktura skrobnih granula mogu uticati na funkcionalna svojstva, fizičko-hemijske karakteristike brašna, kvalitet i ukus krajnjeg proizvoda. U ovom istraživanju ispitivano jeintegralno brašno šestgenotipova pšenice, od toga tri standardnog sadržaja amiloze (22%,24% i 28%), jedan visokoamilozni (36,5% amiloze) i dva voskovca(100% amilopektin).Paramtri ispitivanih uzoraka poređeni su sa komercijalnim rafinisanim brašnom (21,5% amiloze).Nakon određivanja hemijskog sastava, analiziran je kapacitetbrašna na upijanjerazličitih rastvarača (SRC -*solvent retention capacity*), i izračunat jeindeks učinka glutena (GPI - *gluten performance index*).Kapacitet apsorpcije vode kreatao se od 72,61 do 84,16%, mlečne kiseline od 77,01 do 91,81%, natrijum karbonata od 79,92 do 97,83%, saharoze od 93,78 do 116,20%, dok je GPI varirao od 0,43 do 0,45. Sadržaj vlakana bio je u negativnoj korelaciji sa ispitivanim parametrima koji utiču na funkcionalna svojstva brašna. Na osnovu vrednosti upijanja različitih rastvarača, kao i indeksa učinka glutena, integralna brašna ispitivanih genotipova pšenice mogu naći primenu prvenstveno u proizvodnji hleba, kao i u konditorskoj industriji. Ova metoda može biti korisna u procesu selekcije genotipova pšenice kada su u fokusu funkcionalna svojstava brašna neophodna za poboljšanje kvaliteta pojedinih pekarskih proizvoda.

Ključne reči:pšenica, skrob, amiloza, funkcionalna svojstva, integralno brašno.

Zahvalnica: Istraživanje je podržalo Ministarstvo nauke, tehnološkog razvoja i inovacija Republike Srbije (Grant br. 451-03-47/2023-01/200040).

THE EFFECT OF WHEAT GENOTYPE ON THE FUNCTIONAL PROPERTIES OF WHOLE-GRAIN FLOUR

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Wheat flour obtained by grinding the whole grain is a rich source of nutrients, dietary fiber, complex carbohydrates, proteins, B-group vitamins, minerals, and antioxidants that play an important role in the prevention of cancer and cardiovascular diseases. Normal wheat starch consists of an average of 22–35% amylose, while waxy starch contains about 100% amylopectin. The different ratio of the basic components of starch, amylose and amylopectin, as well as the starch granules'structure can affect the functional, physical and chemical properties of flour, quality and taste of the final product. In this research, whole-grain flour of six genotypes of wheat was examined, of which three had standard amylose content (22%, 24% and 28%), one high-amylose (36.5%) and two waxy (100% amylopectin). The parameters of the tested samples were compared with commercial refined flour (21.5% amylose). After determining the chemical composition, the solvent retention capacities of the flour (SRC) were analyzed, and their gluten performance index (GPI) was calculated. The water SRC ranged from 72.61 to 84.16%, lactic acid from 77.01 to 91.81%, sodium carbonate from 79.92 to 97.83%, sucrose from 93.78 to 116.20%, while the GPI varied from 0.43 to 0.45. The fiber content was negatively correlated with the tested parameters that affect the flour's functional properties. Based on the SRC values of different solvents, and the GPI, whole-grain flour of the tested wheat genotypes can be used primarily in bread production, and in the confectionery industry. This method can be useful in the wheat breeding process with focus on the flour'sfunctional properties necessary for improving the quality of certain bakery products.

Keywords:wheat, starch, amylose, functional properties, whole-grain flour.

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II-POS-55

PRODUKTIVNOST I KVALITET CRNOG OVSA *Avena strigosa* SCHREB. I BENEFIT ZA ZDRAVLJE

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Crni ovas *Avena strigosa* Schreb. se u svetu i kod nas gaji na malim površinama. Zahvaljujuću visokoj nutritivnoj vrednosti, visokovrednim proteinima, vitaminima B grupe, i nutrijentima (kalcijum, kalijum, magnezijum, natrijum, silicijum, gvožđe, mangan, cink i bakar) kao i flavonoidima i skrobu, koristi se za ishranu ljudi i stoke, za industrijsku preradu, a u farmaceutskoj industriji i medicini kao prirodan lek. Ovas povoljno deluje na kvalitet kostiju, jača imunitet, povoljno utiče na prostatu, nesanicu, anksioznost, depresiju, nervozu, promuklost, snižava nivo holesterola i telesnu masu, visok krvni pritisak i šećer u krvi. Čaj od ovsa se posebno preporučuje obolelima od multiple skleroze i kod lečenja dijabetesa. U ovoj studiji ispitivana je produktivnost crnog ovsa u dve varijante: V1-kontrola-bez prihrane i u V2-varijanti sa folijarnom prihranom, na proizvodnim parcelama Instituta za ratarstvo i povrtarstvo u Bačkom Petrovcu. Rezultati ispitivanja su pokazali da je crni ovas ispoljio visoke prinose zrna po biljci u nepovoljnoj godini za proizvodnju, a da je u varijanti sa prihranom ostvaren statistički značajno veći prinos u odnosu na kontrolu. Analiza varijanse pokazuje da postoje značajne razlike između varijante prihrane i prinosa (Fekp= 11,605), varijante i mase biljaka (Fekp= 63,258), varijante i visine biljaka (Fekp= 107,700) i varijante prihrane i dužine korena (Fekp= 77,780). Utvrđene su pozitivne korelacione veze između prinosa zrna i mase biljke (r=0.92), visine biljke (r=0.92) i dužine korena (r=0.99). Rezultati pokazuju da crni ovas može uspešno da se gaji i u nepovoljnim godinama uz primenu folijarne prihrane i adekvatne tehnologije gajenja. Prihrana je poželjna u usevu crnog ovsa u cilju povećanja prinosa i ostvarenja profitabilne proizvodnje.

Ključne reči: crni ovas, parametri rodnosti, folijarna prihrana, uticaj na zdravlje

Zahvalnica: Rad je nastao kao rezultat istraživanja u okviru projekta i Ugovora o realizaciji i finansiranju naučnoistraživačkog rada NIO u 2023. godini između Ministarstva nauke, tehnološkog razvoja i inovacija Repulike Srbije i Instituta za ratarstvo i povrtarstvo, evidencioni broj Ugovora: 451-03-47/2023-01/200032; i brojeva 2000003; 200045 i 200358; kao i FAO projekta: The Benefit-Sharing Fund of the International Treaty on Plant Genetic Resources for Food and Agriculture project "Redesigning the exploitation of small grains genetic resources towards increased sustainability of grain-value chain and improved farmers' livelihoods in Serbia and Bulgaria—GRAINEFIT" (2020-2024), project number PR-166-Serbia.

PRODUCTIVITY AND QUALITY OF BLACK OATS -*Avena strigosa* SCHREB. AND HEALTH BENEFITS

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Black oats *Avena strigosa* Schreb. is grown in the world and in our country in small areas. Thanks to its high nutritional value, high-value proteins, B group vitamins, and nutrients (calcium, potassium, magnesium, sodium, silicon, iron, manganese, zinc and copper), as well as flavonoids and starch, it is used for human and livestock nutrition, for industrial processing, in the pharmaceutical industry and medicine as a natural medicine. Oats have a beneficial effect on the quality of bones, strengthen immunity, have a beneficial effect on the prostate, insomnia, anxiety, depression, nervousness, hoarseness, lower cholesterol levels and body weight, high blood pressure and blood sugar. Oat tea is especially recommended for patients with multiple sclerosis and in the treatment of diabetes. In this study, the productivity of black oats was examined in two variants: V1-without nutrition (control) and in V2-variant with foliar nutrition, on the Institute of Field and Vegetable Crops experimental field, in Bački Petrovac. The results showed that black oats showed high grain yields per plant, in an unfavourable year for production, and that in the variant with top dressing, a statistically significantly higher yield was achieved compared to the control. Analysis of variance shows that there are significant differences between the variants of nutrition and yield (Fekp= 11.605), the variants of nutrition and the plant weight (Fekp= 63.258), plant height (Fekp= 107.700) and root length (Fekp= 77.780). There were positive correlations between grain yield and plant mass (r=0.92), plant height (r=0.92), and root length (r=0.99). The results showed that black oats can be successfully grown even in unfavourable years with the application of foliar fertilisation, followed with proper and timely cultivation technology. Therefore, in order to increase yield and achieve profitable production foliar fertilisation is desirable in the black oat crop production.

Key words: black oats, fertility parameters, foliar fertilisation, impact on health

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II-POS-56

GENETČKA VARIJABILNOST PROFILA DIJETALNIH VLAKANA I NJIHOV UTICAJ NA TEHNOLOŠKI KVALITET BRAŠNA DURUM PŠENICE

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Durum pšenica (*Triticum durum* Desf.) se koristi kao sirovina za testenine, kvasni i beskvasni hleb, kus-kus, i druge proizvode. Tehnološke i nutritivne osobine durum brašna umnogome zavise od sadržaja dijetalnih vlakana, što je osobina koja zavisi od genotipa i uticaja sredine. U cilju utvrđivanja efekata genetičke varijabilnosti sadržaja dijetalnih vlakana korišćeno je dvanaest genotipova durum pšenice gajenih u dve vegetacione sezone. Pored toga, ispitivani su i efekti profila dijetalnih vlakana durum pšenice na reološka svojstva testa. Sadržaj NDF je varirao od 12,68 do 74,06% i od 10,16 do 67,14% u 2020. i 2021. godini, respektivno. Genotip VII-3 sa najvećim udelom nerastvorljivih vlakana, odnosno sadržajem NDF (74,06%), takođe je imao veoma visok procenat hemiceluloze (β-glukana i arabinoksilana) (62,49%). Najveći sadržaj ADF (9,98%) i ADL (7,47%) detektovan je kod genotipa VII-I, dok je genotip Agaton imao 69,4% i 92,0% manji sadržaj ADF i ADL, respektivno. Celuloza i hemiceluloza, kao glavni neskrobni polisaharidi prisutni u durum pšenici, kretali su se od 6,82% do 62,80% i od 8,74% do 60,46%, respektivno. Efekti dijetalnih vlakana na viskozna svojstva integralnog brašna durum pšenice su ispitivani korišćenjem Brabender viskografa. Maksimalni, konačni i naknadni viskozitet su se značajno razlikovali ($p<0,05$) u okviru ispitivanih uzoraka integralnog brašna durum pšenice. Rezultati su pokazali smanjenje maksimalnog viskoziteta i konačnog viskoziteta integralnog durum brašna sa povećanjem sadržaja dijetalnih vlakana.

Ključne reči: dijetalna vlakna, durum pšenica, genotip, viskozitet,integralno brašno.

Zahvalnica: Ovo istraživanje finansirano je od strane Ministarstva nauke, tehnološkog razvoja i inovacija Republike Srbije (broj ugovora: 451-03-47/2023-01/200040).

GENETIC VARIABILITY OF DIETARY FIBRES PROFILE AND THEIR EFFECT ON TECHNOLOGICAL QUALITY OF DURUM WHEAT FLOUR

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Durumwheat (*Triticumdurum*Desf.) is the preferred raw material for pasta, leavened and unleavened breads, couscous, ect.The technological and nutritional properties of durum wheat flour depend mainly on the dietary fibre content, which is a genotype- and environment-dependent trait. In order to determine the effects of the genetic variability of dietary fibre content, twelve durum wheat genotypes cultivated in two growing seasons were used. In addition, the effects of durum wheat dietary fibre profiles on the rheological properties of dough were also investigated. The content of NDF varied from 12.68 to 74.06% and from 10.16 to 67.14% in the years 2020 and 2021, respectively. Genotype VII-3 with the highest insoluble fibre share, i.e. NDF content (74.06%), also had a very high percentageofhemicellulose (β-glucansandarabinoxylans) (62.49%). The highest content of ADF (9.98%) and ADL (7.47%) were detected in genotype VII-I, while the Agaton genotype was found to have 69.4% and 92.0% lower content of ADF and ALD, respectively. Cellulose and hemicellulose, which are principal non-starch polysaccharides present in durum wheat ranged from 6.82% to 62.80% and from 8.74% to 60.46%, respectively. Effectsof the dietary fibers on the pasting properties of wholegrain durumflourwereinvestigatedusing a Brabenderviscograph.Peakviscosity (PK), finalviscosity (FV) andsetback viscosity (SB) were significantly different ($p<0.05$) among wholegrain durum flours. Results showed a reduction in peak viscosity and final viscosity of the wholegrain durum flours with increasing dietary fiber content.

Keywords:dietary fibre, durum wheat, genotype, viscosity,wholegrain flour.

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II-POS-57

SMARTSUN PROJEKAT: MULTIDISCIPLINARNI PRISTUP U POTRAZI ZA "KLIMATSKI PAMETNIM" SUNCOKRETOM

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Klimatske promene negativno utiču na proizvodnju ratarskih useva, posebno tokom dugih sušnih perioda. Jedan od ključnih pristupa za ublažavanje uticaja ekstremnih klimatskih uslova je oplemenjivanje useva kako bi se poboljšala njihova prilagodljivost različitim uslovima gajenja. Međutim, tradicionalne metode oplemenjivanja su često dugotrajne, radno intenzivne i rezultati evaluacije mogu biti pristrasni. U cilju dubljeg razumevanja adaptivnog odgovora suncokreta na sušne stresove uzrokovane klimatskim promenama, SmartSun projekat primenjuje holistički pristup koji obuhvata digitalnu fenotipizaciju korena suncokreta, analizu epigenetskih mehanizama i integraciju dobijenih podataka mašinskim učenjem. Do sada je razvijen protokol za rani rast korena suncokreta kroz fenotipizaciju u rizotronima pod različitim uslovima zalivanja (70, 42 i 50% zapreminskog sadržaja vode). Testirane su inbred linije suncokreta sa Instituta za ratarstvo i povrtarstvo kako bi se identifikovali tolerantni i osetljivi genotipovi. Identifikovane su ključne morfološke osobine korena koje su pouzdane u razlikovanju osetljivosti na sušu. Dodatno, sprovedena je anatomska karakterizacija vaskularnih tkiva korena, uočavajući prisustvo kseromorfnih elemenata koji ukazuju na potencijalno veću toleranciju na sušu. Analizom epigenetskih mehanizama, kao što su posttranskripcione modifikacije histona, metilacija DNK i ekspresija malih RNK i lncRNA, istražuje se potencijal za prenošenje adaptivnih promena na naredne generacije. Kroz integraciju statističkih metoda i tehnika mašinskog učenja, SmartSun projekat povezuje rezultate dobijene iz fenotipizacije i epigenetičke analize, kako bi se kreirali prilagođeni genotipovi suncokreta koji mogu efikasno odgovoriti na nestabilne, promenljive i sušne uslove gajenja. Značaj SmartSun projekta ogleda se u identifikaciji genotipova suncokreta sa većom tolerancijom na sušu, što može značajno doprineti ublažavanju uticaja klimatskih promena na poljoprivrednu proizvodnju. Ovaj projekat ima perspektivu da obezbedi održivu budućnost za našu planetu, koja se suočava sa sve izraženijim izazovima klimatskih promena.

Ključne reči: suncokret, suša, fenotipizacija, tolerantnost, epigenetika, mašinsko učenje

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SMARTSUN PROJECT: A MULTIDISCIPLINARY APPROACH FOR UNVEILING A "CLIMATE-SMART" SUNFLOWER

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Climate change has a negative impact on the production of field crops, especially during extended periods of drought. One of the key strategies to mitigate the effects of extreme climate conditions is crop breeding aimed at enhancing their adaptability to various growing conditions. However, traditional breeding methods are often time-consuming, labor-intensive, and the evaluation outcomes may be biased. To gain a deeper understanding of the adaptive response of sunflowers to drought stress caused by climate change, the SmartSun Project employs a holistic approach encompassing digital root phenotyping, analysis of epigenetic mechanisms, and the integration of acquired data through machine learning. A protocol for early sunflower root growth has been developed using phenotyping in rhizotrons under different watering conditions (70%, 42%, and 50% volumetric water content). Inbred sunflower lines from the Institute of Field and Vegetable Crops (IFVCNS) were tested to identify tolerant and sensitive genotypes. Key morphological root traits that reliably differentiate drought sensitivity have been identified. Furthermore, an anatomical characterization of root vascular tissues has been conducted, observing the presence of xeromorphic elements indicative of potential increased drought tolerance. Epigenetic mechanisms analysis, such as post-transcriptional histone modifications, DNA methylation, and the expression of small RNAs and lncRNAs, explores the potential for transmitting adaptive changes to subsequent generations. Through the integration of statistical methods and machine learning techniques, the SmartSun Project connects results obtained from phenotyping and epigenetic analysis to create customized sunflower genotypes capable of effectively responding to unstable, variable, and dry growing conditions. The significance of the SmartSun Project lies in the identification of sunflower genotypes with higher drought tolerance, which can significantly contribute to mitigating the impact of climate change on agricultural production. This project holds the perspective of securing a sustainable future for our planet, facing increasingly pronounced challenges posed by climate change.

Key words: sunflower, drought, phenotyping, tolerance, epigenetics, machine learning

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OCENA STABILNOSTI PRINOSA SEMENA I KOMPONENTI PRINOSA NS KONZUMNIH HIBRIDA SUNCOKRETA PRIMENOM AMMI ANALIZE

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Povećana upotreba biljnih proteina u prehrambenoj industriji postavila je nove ciljeve oplemenjivačkom programu konzumnog suncokreta. Ispitivanje adaptabilnosti novih konzumnih hibrida suncokreta je važan deo programa oplemenjivanja. Petnaest NS konzumnih hibrida suncokreta ispitivano je tri godine na lokaciji Rimski Šančevi, u ogledu postavljenom kao randomizovani blok dizajn sa tri ponavljanja. REML slučajni model je korišćen za procenu efekata hibrida, godina i njihove interakcije, dok je AMMI analiza primenjena za određivanje interakcije genotipa i okruženja. Upoređen je efekat genotipova (G), okruženja (E) i njihove interakcije (GE) s obzirom na njihov doprinos ukupnoj varijansi. Za prinos semena glavni efekat E (49,32%) je bio važniji od GE (38,98%) i G efekata (11,70%), što pokazuje da prinos semena ispitivanih genotipova suncokreta više zavisi od uslova sredine nego od genotipa. U pogledu sadržaja proteina i ulja u semenu, efekat G (52,2%;70,63%) je imao značajniju ulogu od efekata E (17,0%;19,36%) i GE (30,8%;10%). AMMI analiza je pokazala da je hibrid NS H7 imao najveću stabilnost prinosa semena i sadržaja proteina u semenu kao i veći sadržaj ulja u semenu u poređenju sa drugim ispitivanim hibridima. Konzumni hibrid NS H15 je perspektivan hibrid, koji je pokazao nizak sadržaj ulja i visok sadržaj proteina u semenu i visoku stabilnost u datim uslovima. Nastaviće se sa ispitivanjem NS konzumnih hibrida primenom AMMI analize kako bi se procenio višegodišnji uticaj genotipa, sredine i njihove interakcije na prinos semena, sadržaj proteina i ulja u semenu.

Ključne reči: konzumni hibridi, prinos semena, sadržaj proteina i ulja u semenu, REML, AMMI

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ASSESSMENT OF STABILITY OF SEED YIELD AND YIELD COMPONENTS IN NS CONFECTIONERY SUNFLOWER HYBRIDS USING THE APPLE AMMI ANALYSIS

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The increased use of vegetable proteins in the food industry has imposed new goals on the confectionery sunflower breeding program. Testing the adaptability of new NS confectionery sunflower hybrids is an important part of the breeding program. Fifteen NS confectionery sunflower hybrids were tested over a period of three years in an experiment set up as a randomized block design with three replications at the Rimski Šančevi location. The REML random model was used to evaluate the effects of hybrid, year, and their interaction, while AMMI analysis was applied to determine the interaction between genotype (G) and environment (E). The effect of G, E, and their interaction (GE) was compared with respect to their contribution to the total variance. For seed yield, the main effect of E (49.32%) is more important than the GE effect (38.98%) and G effect (11.70%), which shows that sunflower seed yield, of investigated hybrids, depends more on environmental conditions than on genotype. Regarding the content of protein and oil in the seeds, the effect of G (52.2%; 70.63%) had a more significant role than the effects of E (17.0%; 19.36%) and GE (30.8%; 10%). According to AMMI analysis, hybrid NS H7 had the highest stability of seed yield and seed protein content, as well as higher seed oil content compared to other tested hybrids. The confectionery hybrid NS H15 is a promising hybrid, which showed low oil content and high protein content in the seeds and high stability in the given conditions. The examination of NS confectionery hybrids will continue using AMMI analysis in order to evaluate the multi-year influence of genotype, environment, and their interaction on seed yield, protein, and oil content in seeds.

Key words: confectionery hybrids, stability, seed oil and protein content, REML, AMMI

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ANALIZA GENOTIPA, SREDINE I NJIHOVE INTERAKCIJE NA SVOJSTVA SEMENA KONZUMNOG SUNCOKRETA

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Oplemenjivanje konzumnog suncokreta odlikuje se činjenicom da različita tržišta imaju različite zahteve u pogledu veličine semena, boje ljuske i drugih osobina, što ovaj proces čini težim i skupljim. Krupne frakcije semena se otkupljuju, prže i pakuju pojedinačno, dok se sitnije frakcije semena koriste u proizvodnji hladno ceđenog suncokretovog ulja i pogače. Prerađivačka industrija, odnosno male fabrike, otkupljuju seme krupne frakcije za pečenje i pakovanje. Da bi se razumeo doprinos genotipoa, spoljne sredine i njihove interakcije na varijabilnost osobina, korišćen je REML slučajni model za procenu komponenti varijanse faktora za svaku osobinu. Efekat genotipova (G), spoljašnje sredine (E) i njihove interakcije (GE) upoređeni su uzimajući u obzir njihov doprinos ukupnoj varijansi za udeo jezgra i ljuske ,dužine, širine i debljine semena. Kod nekih ispitivanih osobina G efekti su veoma visoki u poređenju sa E i GE efektom, a kod nekih su bili relativno niski. G efekat udela jezgra, udela ljuske i dužine semena objašnjavaju više od 70% ukupne varijacije. Između 36,69% i 50,26% ukupne varijacije širine i debljine semena objašnjeno je G glavnim efektom. Ukupna varijacija debljine semena objašnjena je E glavnim efektom (47,17%) i njegov doprinos varijansi je bio veći od G glavnog efekta (36,30%) i GE efekata (16,53%). Nastaviće se istraživanja NS konzumnih hibrida kako bi se procenio uticaj genotipa, spoljašnje sredine i njihove interakcije na udeo jezgra i ljuske, dužinu, širinu i debljinu semena konzumnog suncokreta.

Ključne reči: konzumni suncokret, REML, udeo jezgra, udeo ljuske, dužina ,širina i debljina semena

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ANALYSIS OF GENOTYPES, ENVIRONMENTS, AND THEIR INTERACTION ON CONFECTIONARY SUNFLOWER SEED TRAITS

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Confectionary sunflower breeding is characterized by different markets having different demands for seed size, hull color, and other traits, thus making this process more difficult and costly. Large seed fractions are purchased, roasted, and packed individually, while smaller seed fractions are used in the production of cold-pressed sunflower seed oil and oil cake. The processing industry, that is, small factories, buy large seed fractions for backing and packaging. To understand the contribution of genotypes, years, and their interaction to the variability of traits, REML random model was used to estimate the variance components of factors for each trait. The effect of genotypes (G), environments (E), and their interaction (GE) was compared by considering their contribution to the total variance for kernel and shell ratio, seed length, width, and thickness. For some investigated traits, G effects were found to be very high compared to the E and the GE effect, and in some, it was relatively low. The G effects on kernel ratio, shell ratio, and seed length explained more than 70% of the total variation. Between 36.69% and 50.26% of the total variation seed width and thickness were explained by the G main effect. The total variation in seed thickness was explained by the E main effect (47.17%), and its contribution to the variance was higher than the one of the G main effect (36.30%) and the GE main effect (16.53%). The research of NS confectionery hybrids will continue to evaluate the influence of genotype, environment, and their interaction on kernel and shell ratio, seed length, width, and thickness of confectionary sunflower.

Key words: confectionery hybrids, REML, kernel ratio, shell ratio, seed length, width, and thickness

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UTICAJ DUŽINE VEGETACIJE GENOTIPA I DATUMA SETVE NA POKROVNOST USEVA SUNCOKRETA

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Različiti vremenski okviri setve i karakteristike genotipova značajno utiču na varijacije u pokrovnosti useva suncokreta. Istraživanja ukazuju na mogućnost optimizacije pokrovnosti useva putem prilagođavanja datuma setve i odabira genotipa, posebno uzimajući u obzir dužinu vegetacije. Razvijeniji habitus biljke može značajno olakšati proces kontrole korova u suncokretu, pružajući veću pokrovnost, koja sprečava dalji rast korova. Cilj ovog rada bio je da se ispita pokrovnost tri inbred linije suncokreta različite dužine vegetacije: ultra rana, srednje rana i kasna i njihov habitus kroz četiri različita roka setve i četiri perioda merenja: 30, 40, 50 i 60 dana nakon nicanja. Korišćenjem aplikacije „CANAPEO", sprovedeno je detaljno merenje habitusa biljke suncokreta. Analiza varijanse korišćena je da bi se uočile razlike između habitusa kod različitih inbred linija, datuma setve i datuma merenja. Primećeno je da su inbred linije, datum setve i njihova interkacija imali značajan uticaj na habitus biljke tokom većine perioda merenja. Analiza rezultata pokazuje da nakon 30, 40, 50 i 60 dana od nicanja, poslednji rok setve i srednje rana inbred linija u proseku ostvaruje najveći habitus biljke, odnosno pokrovnost useva suncokreta. Srednje rana inbred linija sucnokreta nakon 60 dana od nicanja pokriva više od 99% površine zemlje i ne dopušta dalji rast korova. Može se zaključiti da primenom fenotipske analize habitusa biljke postoji mogućnost za efikasnije suzbijanje korova. Takođe, ističe se da uz pomeranje datuma setve prema kasnijem, dolazi do brže i efikasnije pokrovnosti tla ispod svih inbred linija suncokreta, što doprinosi efikasnom suzbijanju rasta korova.

Ključne reči: inbred linija suncokreta, pokrovnost, datum setve

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THE INFLUENCE OF GENOTYPE VEGETATION LENGTH AND SOWING DATE ON SUNFLOWER CROP CANOPY

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Different sowing dates and genotype characteristics significantly influence variations in sunflower canopy. Various studies indicate the potential for optimizing crop canopy through adjusted sowing times and genotype selection, particularly considering vegetation length. A more developed plant habitus can considerably facilitate weed control in sunflower fields, providing enhanced coverage that impedes further weed growth. The aim of this study was to examine the coverage of three different sunflower inbred lines with varying vegetation lengths: ultra-early, mid-early, and late, across four different sowing dates and four measurement periods: 30, 40, 50, and 60 days after emergence. Through the utilization of the "CANAPEO" application, a comprehensive measurement of sunflower plant habitus was conducted. Analysis of variance was employed to discern differences in habitus among different inbred lines, sowing dates, and measurement periods. It was observed that inbred lines, sowing dates, and their interaction significantly impacted plant habitus throughout most measurement periods. The results indicated that 30, 40, 50, and 60 days post-emergence, last sowing date and mid-early inbred line on average achieved the biggest habitus i.e. crop canopy. The mid-early inbred line covered over 99% of the ground surface after 60 days from emergence, preventing further weed growth. In conclusion, the application of phenotypic analysis of plant habitus presents an opportunity for efficient weed suppression. Additionally, shifting the sowing date towards later periods results in faster and more effective soil coverage beneath all sunflower inbred lines, contributing to effective weed growth inhibition.

Key words: sunflower inbred line, canopy, sowing date

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MODERNI TRENDOVI U OPLEMENJIVANJU SUNCOKRETA

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Prema trenutnom trendu rasta svetske populacije očekivanja su da će ukupan broj stanovnika do 2050. godine iznositi 9,6 milijardi, što je povećanje više od 10% u odnosu na trenutnu situaciju. Pored toga, prosečna svetska temperatura raste i beleži rekorde svake godine, praćena abnormalnim klimatskim fenomenima poput superćelijskih oluja. Pored mnogobrojnih biotičkih faktora koji stvaraju probleme u gajenju useva, rekordne temperature uz nepredvidive obrazce padavina predstavljaju sve izazovnije uslove za uspešnu proizvodnju. Na globalnom nivou, suncokret predstavlja stratešku ratarsku biljnu vrstu, zbog povećanja tražnje za njegovim uljem kao i relativno umerenih zahteva za proizvodnju, u odnosu na druge useve. Imajući u vidu navedene činjenice, od suštinskog je značaja primenjivati inovativne tehnike u oplemenjivanju suncokreta u svrhu razvoja genotipova sposobnih da se odupru izazovima biotičkog i abiotičkog stresa kao što su različite štetočine, bolesti, visoke temperature, suša i dr. S tim u vezi, neki od aktuelnih trendova u oplemenjivanju biljaka, suncokreta su precizna modifikacija gena unutar genoma (CRISPR-Cas9), digitalizovano oplemenjivanje zasnovano na velikom setu podataka uz primenu bioinformatike u cilju genomskog predviđanja, kao i precizna fenotipizacija i primena epigenetike u svrhu oplemenjivanja na tolerantnost prema abiotskim faktorima izazvanim učestalim klimatskim promenama (climate resilient varieties). Jedan od takvih pristupa jeste SMARTSUN projekat Instituta za ratarstvo i povrtarstvo iz Novog Sada koji primenom savremenih metoda precizne fenotipizacije uz genotipska i epigenetska istraživanja ispituje mehanizme prilagođavanja suncokreta na ekstremne abiotske faktore, prvenstveno sušu, kao sve češću pojavu izazvanu klimatskim neregularnostima.

Ključne reči: klimatski fenomeni, suncokret, biotički i abiotički stres, fenotipizacija

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MODERN TRENDS IN SUNFLOWER BREEDING

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According to the current trend of world population growth, expectations are that the total number of inhabitants will reach 9.6 billion by 2050, which is an increase of more than 10% compared to the current situation. In addition, the average global temperature is rising and setting records every year, accompanied by abnormal climate phenomena such as supercell storms. In addition to numerous biotic factors that create problems in growing crops, record temperatures and unpredictable rainfall present increasingly challenging conditions for successful production. At the global level, sunflower represents a strategic field crop specie, due to the increasing demand for its oil, as well as relatively moderate production requirements, compared to other crops. Bearing in mind the above facts, it is essential to apply innovative techniques in sunflower breeding in order to develop genotypes capable of resisting the challenges of biotic and abiotic stress such as various pests, diseases, high temperatures, drought, etc. In this regard, some of the current trends in plant breeding, including sunflower, are precise gene modification within the genome (CRISPR-Cas9), digitized breeding based on a large data set with the application of bioinformatics for genomic prediction, as well as precise phenotyping and the application of epigenetics for the purpose of breeding for tolerance to abiotic factors caused by frequent climate changes (climate resilient varieties). One of such approaches is the SMARTSUN project of the Institute of Field and Vegetable Crops from Novi Sad, which, using modern methods of precise phenotyping along with genotypic and epigenetic research, examines the mechanisms of adaptation of sunflower to extreme abiotic factors, primarily drought, as an increasingly frequent phenomenon caused by climatic irregularities.

Key words: climatic phenomena, sunflower, biotic and abiotic stress, phenotyping

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PRINOS I KOMPONENTE PRINOSA SUNCOKRETA U ZAVISNOSTI OD RAZVIJENOSTI KORENOVOG SISTEMA

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Prednost gajenja suncokreta je njegova sposobnost da dobro koristi vodu i hranljive materije iz zemljišta zahvaljujući korenu koji prodire duboko u zemljište, ima dobru usisnu snagu i razvijenost. Prilikom testiranja klijavosti partija semena uočeno je da se u pojedinim godinama kod klijanaca u većoj meri ispoljava nedostatak primarnog korena te je i obavljeno istraživanje sa ciljem da se utvrdi da li ova pojava značajno utiče na prinos, masu 1000 semena i sadržaj ulja tri hibrida suncokreta. Ogled je bio postavljen na dva lokaliteta tokom dve proizvodne godine po split-plot metodu. Parcelice su formirane biljkama razvijenim iz klijanaca sa kompletnim korenom, druga biljkama razvijenim iz klijanaca bez primarnog korena, dok je treća parcelica predstavljala kombinaciju prethodne dve, zavisno od procentualnog učešća klijanaca bez primarnog korena u polaznoj partiji semena. Najveći prinos semena ostvaren je kod useva sa kompletnim korenom, kod hibrida NS-H-111 i Sumo 2 OR i značajno veći u odnosu na prinos useva bez primarnog korena. Masa 1000 semena hibrida NS-H-111 je kao i prinos bila najveća u prvoj varijanti, kod hibrida Oliva u drugoj, dok je kod hibrida Sumo 2 OR najveća vrednost utvrđena kod useva koji je formiran kombinacijom biljaka sa i bez primarnog korena. Značajno najveći sadržaj ulja hibrida NS-H-111 imao je usev bez primarnog korena, dok je kod hibrida Oliva značajno veći bio kod useva sa kompletnim korenom. Kod hibrida Sumo 2 OR značajnih razlika nije bilo. Razvijenost korena je značajno uticala na prinos i komponente prinosa, a utvrđen je i značajan uticaj samog genotipa.

Ključne reči: suncokret, koren, prinos, masa 1000 semena, sadržaj ulja

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INFLUENCE OF ROOT DEVELOPMENT ON SUNFLOWER YIELD AND YIELD COMPONENTS

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Sunflower's ability to make good use of water and nutrients from the soil by means of strong root represents its cultivation advantage. During the seed lots germination testing, it was observed that the lack of a primary root is significantly manifested in seedlings occasionally, and research was carried out with the aim of determining whether this phenomenon significantly affects the yield, 1000 seed weight and oil content of three sunflower hybrids. The experiment was set up on two locations during two production years using the split-plot method. The plots were formed by plants developed from seedlings with a complete root, the second by plants without a primary root, and the third was a combination of the previous two, depending on the percentage participation in the initial seed lot. The highest seed yield was achieved in crops with complete roots, and in hybrids NS-H-111 and Sumo 2 OR it was significantly higher. The weight of 1000 seeds was the highest in the first variant at NS-H-111, in the second variant at Oliva, while the highest value was determined in the crop with and without primary roots at Sumo 2 OR. NS-H-111 had a significantly highest oil content at a crop without a primary root, while in hybrid Oliva was in crop with complete roots. In the case of the hybrid Sumo 2 OR, no significant differences were found. Root development had a significant impact on yield and yield components, and a significant influence of the genotype itself was also determined.

Key words: sunflower, root, yield, weight of 1000 seeds, oil content

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PERSPEKTIVNE LINIJE KUPUSA SA VISOKIM SADRŽAJEM ŠEĆERA

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Usmeravajući selekciju kupusa prema potrebama tržišta u kvalitetu u prinosu i otpornosti u Institutu za povrtarstvo S. Palanka selekcionisano je 7 linija iz populacije Izpscc u kojoj je detektovan visok sadržaj šećera i to u rasponu od 6,1 do 9,6%, a prosek je 3,8 - 4,2%. Selekcija linija započeta je metodom individualnog odabiranja iz populacije, a nastavljena je Pedigre metodom. Osnovni kriterijumi pri selekciji bili su; erektofilna rozeta, listovi sa dugačkom lisnom drškom koja olakšava fototropizme, dva ovojna lista zelene boje, unutrašnji kočan kraći od 50% visine glavice i sadržaj ukupnih šećera viši od 7,5 %, dobro zbijena glavica kao i masa glavice preko 1,6 kg. Ogled sa 7 selekcionisanih linija: G1, G2, G3, G4, G5, G6 i G7 postavljen je u 3 ponavljanja na oglednom polju Instituta za povrtartsvo tokom 2020, 2021. i 2022. Pored osobina: glavice, rozete i uniformnosti, praćena je stabilnost sadržaja ukupnžnih šećera (%). AMMI analiza (glavni aditivni efekti i višestruka interakcija) za osobinu ukupnog sadržaja šećera pokazala je najveću stabilnost linije G3, dok su G2 i G5 bile sledeće u rangiranju po stabilnosti, u svim ispitivanim sezonama. Sadržaj šećera kod G3 u 2020. iznosio je prosečno 8,5%, u 2021 8,9%, dok je sadržaj šećera u 2022. godini bio najniži i prosečno je iznosio 7,7%. Najveći sadržaj šećera izmeren je kod linije G5 u 2021 i iznosio je 9,6%. Odabrane linije G3, G2 i G5, visokog genetičkog potencijala za sadržaj šečera iskorišćene su kao očinske linije u procesu selekcije visokoprinosnih, otpornih i slatkih srednje kasnih i kasnih hibrida kupusa koji se očekuju na tržištu od 2027. godine.

Ključne reči: selekcija, linije kupusa, stabilnost šećera

Zahvalnica: Ovo istraživanje je sprovedeno uz podršku Ministarstva nauke i tehnološkog razvoja Republike Srbije (broj ugovora: 451-03-47/2023-01/200216).

PROSPECTIVE LINES OF CABBAGE WITH HIGH SUGAR CONTENT

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Directing the selection of cabbage according to the needs of the market in terms of quality, yield and resistance, 7 lines from the Izpscc population were selected in the S. Palanka Institute of Vegetables, in which high sugar content was detected, ranging from 6.1 to 9.6%, and the average is 3.8 - 4.2%. The selection of lines was started with the method of individual selection from the population, and continued with the Pedigree method. The basic selection criteria were; erectophilic rosette, leaves with a long petiole that facilitates phototropism, two sheathing leaves of green color, inner stem shorter than 50% of the height of the head and content of total sugars higher than 7.5%, well-compacted head as well as head weight over 1.6 kg. An experiment with 7 selected lines: G1, G2, G3, G4, G5, G6 and G7 was set up in 3 replications on the experimental field of the Institute of Vegetables during 2020, 2021 and 2022. In addition to the characteristics: heads, rosettes and uniformity, stability was monitored content of total sugars (%). AMMI analysis (*additive main effects and multiplicative interaction*) for the trait of total sugar content showed the highest stability of the G3 line, while G2 and G5 were ranked next in terms of stability, in all investigated seasons. The sugar content of G3 in 2020 averaged 8.5%, in 2021 8.9%, while the sugar content in 2022 was the lowest and averaged 7.7%. The highest sugar content was measured for the G5 line in 2021 and was 9.6%. Selected lines G3, G2 and G5, with high genetic potential for sugar content, were used as paternal lines in the selection process of high-yielding, resistant and sweet mid-late and late cabbage hybrids expected on the market from 2027.

Key words: selection, cabbage lines, sugar stability

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GENOTIPSKI ODGOVOR NA UTICAJ RAZLIČITIH FORMULACIJA AZOTNIH ĐUBRIVA KOD ZELENE SALATE (*LACTUCA SATIVA* L.)

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Primenom azotnih mineralnih đubriva povećava se usvajanje nitrata, a time i njihov sadržaj u biljkama. Pri utvrđivanju doze azota neophodno je dovesti u sklad prinos i sadržaj nitrata u zelenoj salati (*Lactuca sativa*). Cilj ovog eksperimenta bio je da se utvrdi uticaj različitih formulacija azotnih mineralnih đubriva (nitratni–KAN, amidni–urea, amonijačni–amonijum sulfat i kontroli tretman bez đubrenja) na antioksidativni profil, sadržaj vitamina C, ukupan sadržaj nitrata, visinu glavice i masu kod pet genotipova zelene salate G-12, Z-6, MK, A-2, N-8. Eksperiment je sproveden u plasteniku u Trbušanima u toku 2023. godine, po slučajnom blok sistemu u 4 ponavljanja. Statistička analiza je izvedena prema dvofaktorijalnoj analizi varijanse (ANOVA) pri čemu su utvrđeni interakcijskim odnosi između genotipova i pojedinih formulacija azotnih đubriva, kao i pojedinačni uticaji genotipa i đubriva na ispitivane parametre. Za sadržaj nitrata kontrola se razlikovala od tretmana đubrivom, ali i pojedine formulacije đubriva razlikovale su se između sebe. Genotipovi su takođe imali razlike u akumulaciji nitrata. Slično je utvrđeno kod sadržaja vitamina C, dok je kod antioksidativnog efekta utvrđena razlika samo kod kontrole u odnosu na đubrenje. Đubriva nisu imala uticaja na antioksidativnu aktivnost salate, dok je za genotipove utvrđena je značajnost u razlici N-8 i Z-6 u odnosu na ostale genotipove. Masa glavice je bila različita za svih pet genotipa. Obzirom da različiti genotipovi raazličito reaguju na primenu pojedinih formulacija azotnih đubriva, potrebno je za svaki genotip odrediti optimalnu primenu azotnog đubriva.

Ključne reči: zelena salata, genotipovi, azotna đubriva

Zahvalnica: Ovo istraživanje je finansiralo Ministarstvo prosvete, nauke i tehnološkog razvoja Republike Srbije, broj projekta 451-03-47/2023-01/200088 i 451-03-47/2023-01/200217.

GENOTYPE'S RESPONSE TO THE INFLUENCE OF DIFFERENT NITROGEN FORMULATIONS FERTILIZERS FOR LETTUCE (*LACTUCA SATIVA* L.)

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The use of nitrogen mineral fertilizers increases the absorption of nitrates, and thus their content in plants. When determining the nitrogen dose, it is necessary to harmonize the yield and nitrate content in lettuce (*Lactuca sativa*). The aim of this experiment was to determine the influence of different formulations of nitrogen mineral fertilizers (nitrate-KAN, amide-urea, ammonia-ammonium sulphate and control treatment without fertilization) on the antioxidant profile, vitamin C content, total nitrate content, head height and weight in five genotypes of lettuce G-12, Z-6, MK, A-2, N-8. The experiment was conducted in a greenhouse in Trbušani during the year 2023, according to a random block system in 4 repetitions. The statistical analysis was performed according to the two-factor analysis of variance (ANOVA), where the interaction relations between genotypes and individual formulations of nitrogen fertilizers were determined, as well as the individual effects of genotype and fertilizer on the examined parameters. For nitrate content, the control differed from the fertilizer treatment, but individual fertilizer formulations also differed from each other. Genotypes also had differences in nitrate accumulation. Similar results were found for the vitamin C content, while a difference was found for the antioxidant effect only in the control compared to fertilization. Fertilizers had no effect on the antioxidant activity of lettuce, while for the genotypes, significance was determined in the difference between N-8 and Z-6 compared to the other genotypes. The weight of the head was different for all five genotypes. Given that different genotypes react differently to the application of individual nitrogen fertilizer formulations, it is necessary to determine the optimal application of nitrogen fertilizer for each genotype.

Key words: lettuce, genotypes, nitrogen fertilizers

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PRIMENA MODERNE FENOTIPIZACIJE U OPLEMENJIVANJU BILJAKA U SRBIJI

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Prateći evropske i svetske trendove, u programima oplemenjivanja biljaka u Srbiji se tokom poslednje decenije intenzivnije koriste alati i platforme za fenotipizaciju biljaka visoke propusnosti (HTPP). Na početku, oplemenjivačke grupe su koristile različite projekte međunarodne saradnje za pristup modernim HTPP platformama. U ovim projektima, analizirane su kolekcije lokalnih genotipova pšenice, soje, uljane repice, kukuruza i suncokreta u kontrolisanim uslovima korišćenjem HTPP opreme. Dobijeni su veoma dragoceni podaci o reakciji ispitivanih vrsta i genotipova na nedostatak azota, zaslanjenost zemljišta, visoke temperature, sušu i druge stresove. Analizirane su brojne važne osobine, kao što su sveža i suva biomasa, osobine vezane za prinos, potrošnja vode, fotosintetička aktivnost, akumulacija prolina, hlorofila i ugljenih hidrata i mnoge druge, obezbeđujući korisne informacije za dalje oplemenjivanje na poboljšanje tolerantnosti prema stresu, što je posebno važno u uslovima klimatskih promena. U sledećoj fazi, istraživačke i oplemenjivačke institucije su počele da unapređuju sopstvene kapacitete za fenotipizaciju biljaka, prvo prenosnim alatima za fenotipizaciju, a kasnije i rizotronima, bespilotnim letelicama itd. Stoga su merenja NDVI, sadržaja hlorofila i temperature useva već pronašla značajnu ulogu u redovnim aktivnostima oplemenjivanja strnih žita u Institutu. Pored toga, digitalne analize slika koriste se u oplemenjivanju ukrasnog suncokreta, za predviđanje gustine sklopa soje, kao i prinosa i kvaliteta semena uljane repice i suncokreta. Podaci sa multispektralnih kamera priključenih na bespilotne letelice koriste se za ranu procenu stanja useva i zasejanih površina, pružajući proizvođačima i drugim akterima na poljoprivrednom tržištu bolju osnovu za planiranje proizvodnje.

Ključne reči: fenotipizacija biljaka, oplemenjivanje, tolerantnost, stres.

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APPLICATION OF MODERN PHENOTYPING IN PLANT BREEDING IN SERBIA

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High-throughput plant phenotyping (HTPP) tools and platforms have started to be more extensively used during the last decade and integrated into the crop breeding programmes in Serbia. At the beginning, breeding groups have been using different international collaboration projects to access modern HTPP platforms. In these projects, the collections of Serbian wheat, soybean, rapeseed, maize, and sunflower genotypes were analysed under controlled conditions using HTPP equipment. The very valuable data about nitrogen deficiency, salt, heat, drought and other stress-induced responses of the evaluated species and genotypes were obtained. Numerous valuable traits, such as fresh and dry biomass, yield related traits, water consumption, photosynthetic activity, proline, chlorophyll and carbohydrate accumulation, and others were analysed providing useful information for advancing stress tolerance breeding especially important under conditions of the climate change. In the next phase, the research and breeding institutions started to improve their own facilities for plant phenotyping, firstly by portable phenotyping tools, but later also with rhizotrons, UAVs etc. Thus, the NDVI, chlorophyll content, or canopy temperature measurements have already found a significant role in regular small grain breeding activities at IFVC. Digital image analyses are also exploited in ornamental sunflower breeding, for the prediction of soybean plant density, seed yield and quality of rapeseed and sunflower, etc. Also, based on data from multispectral cameras that are attached to UAVs, early assessment of crop condition and the planted area is possible, which is beneficial for farmers and agricultural market stakeholders in terms of better production planning.

Key words: plant phenotyping, breeding, tolerance, stress

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OPLEMENJIVANJE BILJAKA ZA GAJENJE U ZDRUŽENIM USEVIMA

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Povećanje raznovrsnosti gajenih biljnih vrsta ima veliki potencijal za rešavanje ekoloških problema izazvanih modernom poljoprivrednom proizvodnjom, kao što su erozija i gubitak ugljenika u zemljištu, ispiranje hranljivih materija, zagađenje voda i smanjenje biodiverziteta. Oplemenjivanje biljaka, kao i druge oblasti istraživanja u poljoprivredi, prvenstveno je usmereno ka stvaranju sorti za gajenje čistih useva pojedinačno, a vrlo retko u sistemu združenih useva. Kako poljoprivredni inputi postaju sve skuplji, a negativan uticaj izazvan ekstremnim vremenskim promenama sve neposredniji i ekološki efekti dominantnih poljoprivrednih sistema postaju sve jasniji, tako i u oplemenjivanju biljaka postaju aktivniji programi koji podržavaju tzv. alternativnu poljoprivredu. Združeni usevi pružaju mogućnost da se istovremeno podrži produktivnost i stabilnost u poljoprivrednoj proizvodnji, a u isto vreme da se postignu ciljevi održivosti. Prelaskom na sisteme gajenja koji podrazumevaju setvu više useva, oplemenjivački programi se moraju modifikovati uvođenjem novih ciljeva. Tako, pored uobičajenih osobina kao što su visok prinos, kvalitet, tolerantnost na štetočine i bolesti, novostvorene sorte treba da imaju bolju adaptaciju za gajenje u različitim sistemima, uključujući različite plodorede, naizmenične sezonske useve, kao i ekosistemske usluge. U Institutu za ratarstvo i povrtarstvo, u okviru HORIZON EUROPE projekata MIDAS i CARINA, kao i Centra izuzetnih vrednosti za oplemenjivanje biljaka tolerantnih na promene klime – Climate Crops, intenziviran je rad na oplemenjivanju biljaka namenjenih za gajenje u vidu združene setve, a realizuje se kroz njihovo testiranje u različitim sistemima gajenja, i povezuju svi akteri poljoprivredne proizvodnje u okviru tzv. "živih laboratorija" i nacionalnih fokus grupa.

Ključne reči: združeni usev, oplemenjivanje, adaptabilnost.

Zahvalnica: Rad je podržalo Ministarstvo nauke, tehnološkog razvoja i inovacija Republike Srbije, ugovor broj 451-03-68/2022-14/ 200032), Evropska komisija kroz projekte MIDAS, br. 101082070 i CARINA, br. 101081839, kao i Centar izuzetnih vrednosti za inovacije u oplemenjivanju biljaka tolerantnih na promene klime - Climate Crops, Institut za ratarstvo i povrtarstvo, Novi Sad, Srbija.

PLANT BREEDING FOR INTERCROPPING

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Increased diversity of cultivated plant species has a large potential for solving environmental issues caused by modern agricultural production, such as erosion and carbon loss in the soil, nutrient leaching, water pollution and declined biodiversity. Plant breeding, as well as other agricultural areas of study, are primarily directed towards developing cultivars to be grown as a sole crop, and only rarely for intercropping. As the cost of agricultural inputs continue to rise, the direct influence of extreme weather changes become more pronounced, highlighting environmental impact of dominant agricultural systems. This drives increased activity in plant breeding within programs supporting so-called alternative agriculture become more active in plant breeding. Intercropping allows the possibility of simultaneously supporting productivity and stability in agricultural production and reaching sustainability goals. Switching to multiple-crop growing systems means that breeding programs have to be modified by introducing new goals. Thus, apart from usual traits such as high yield, quality, tolerance to pests and diseases, newly-developed cultivars should also be better adapted to be grown in various cropping systems, including different crop rotations, alternating seasonal crops, and to provide ecosystem services. At the Institute of Field and Vegetable Crops, within the HORIZON EUROPE projects MIDAS and CARINA, as well as the Centre of Excellence for Innovations in Breeding Crops Tolerant to Climate Change - Climate Crops, plant breeding for intercropping has intensified, the crops are being tested in different cropping systems, and all stakeholders in agricultural production are connected within the so-called “living labs” and national focus groups.

Key words: intercropping, breeding, adaptability.

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CENTAR IZUZETNIH VREDNOSTI ZA INOVACIJE U OPLEMENJIVANJU BILJAKA TOLERANTNIH NA PROMENE KLIME

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Oplemenjivanje gajenih biljaka je kontinuirani proces usmeren ka povećanju prinosa i poboljšanju njihove otpornosti na biotičke i abiotičke stresove. U novije vreme, česte i često nepredvidive varijacije u klimatskim i tržišnim uslovima su dovele do toga da klasične metode oplemenjivanja ne mogu uvek da obezbede rešenja i blagovremeni odgovor na nove izazove u poljoprivrednoj proizvodnji. Imajući sve ovo u vidu, Institut za ratarstvo i povrtarstvo (IFVCNS) je osnovao Centar izvrsnosti za inovacije u oplemenjivanju biljaka tolerantnih na promene klime – Climate Crops sa ciljem uvođenja i primene novih tehnika oplemenjivanja (NBT), kao i efikasnih platformi za fenotipizaciju u oplemenjivačke programe ratarskih biljaka u IFVCNS. Očekuje se da će aktivnocti u okviru Climate Crops pozitivno uticati na izvrsnost i inovativne kapacitete IFVCNS u oblasti oplemenjivanja biljaka tolerantnih na ekstremne vremenske uslove koji se javljaju kao posledica promene klime. Značaj uvođenja NBT i novih metoda fenotipizacije u oplemenjivanje ratarskih biljaka prepoznat je u Srbiji i regionu i podržan nedavno odobrenim projektima SmartSun (7732457), CROPINNO (101059784), HelEx (101081974) i RER5024, koje finansiraju Fond za nauku Republike Srbije, Evropska komisija i Međunarodna agencija za atomsku energiju. Ovi projekti imaju za cilj uvođenje i primenu NBT, digitalnih platformi za fenotipizaciju, ali i indukovanih mutacija u programe oplemenjivanja kako u IFVCNS, tako i u partnerskim institucijama. Kao deo svih ovih projekata, Climate Crops će dodatno doprineti integraciji savremenih alata u oplemenjivanju i istraživačkim aktivnostima u IFVCNS za kreiranje inovativnih rešenja za useve adaptirane na izazove sa kojima se poljoprivredna proizvodnja suočava u 21. veku.

Ključne reči: promena klime, nove metode oplemenjivanja, fenotipizacija, stress

Zahvalnica: Rad je podržalo Ministarstvo nauke, tehnološkog razvoja inovacija Republike Srbije, ugovor broj 451-03-68/2022-14/ 200032, Fond za nauku R. Srbije, program IDEJE, br. 7732457 (SmartSun), Evropska komisija kroz projekte CROPINNO, br. 101059784 i HelEx, br 101081974, IAEA kroz projekat RER5024 i Centar izuzetnih vrednosti za inovacije u oplemenjivanju biljaka tolerantnih na promene klime - Climate Crops, Institut za ratarstvo i povrtarstvo, Novi Sad, Srbija.

CENTRE OF EXCELLENCE FOR INNOVATIONS IN BREEDING OF CLIMATE-RESILIENT CROPS

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Crop breeding is a continuous process aimed at increasing yields and improving crop resistance to biotic and abiotic stresses. Recently, frequent and often unpredictable variations in climatic and market conditions have led to the fact that classical breeding methods cannot always provide solutions and a timely response to new challenges in agricultural production. With all this in mind, the Institute of Field and Vegetable Crops (IFVCNS) established the Centre of Excellence for Innovations in the Breeding of Climate-tolerant Plants - Climate Crops with the aim of introducing and applying new breeding techniques (NBT), along with efficient phenotyping platforms in crop breeding programs in IFVCNS. It is expected that the activities within Climate Crops will have a positive impact on the excellence and innovative capacities of IFVCNS in the field of breeding plants tolerant to the extreme weather conditions that occur as a result of climate change. The importance of introducing NBT and new phenotyping methods in the crop breeding is recognized in Serbia and the region and supported by the projects SmartSun (7732457), CROPINNO (101059784), HelEx (101081974) and RER5024, financed by the National Science Foundation of Serbia, the EC and the IAEA. These projects aim to introduce and apply NBT, digital phenotyping platforms, but also induced mutations in breeding programs both in IFVCNS and in partner institutions. As part of all these projects, Climate Crops will further contribute to the integration of modern tools in breeding and research activities at IFVCNS to create innovative solutions for crops adapted to the challenges that agricultural production is facing in the 21st century.

Key words: climate change, new breeding techniques, phenotyping, stress

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MULTIDISCIPLINARNI PRISTUP U POVEĆANJU AGROZNANJA I AGROTEHNOLOGIJE U ORGANSKOJ PROIZVODNJI

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Projekat CREDIT Vibes predstavlja vid kreativnosti, istraživanja, obrazovanja, razvoja, inovacija i transformacija gde je prioritet obuka visokokvalifikovanih istraživača kao i drugog neistraživačkog osoblja. CREDIT Vibes je usmeren ka proizvodnji zdravstveno bezbedne hrane za ljude i životinje, uspostavljanju zdravog ekološkog okruženja kao i zdravog života na zdravoj planeti. Vodili smo se idejom da će transformacija/reorganizacija Instituta za kukuruz "Zemun Polje" uticati na unapredjenje nauke i tehnologije u poljoprivredi Srbije i na taj način povećati broj projekata kojima se može upravljati. Samim tim i drugi Instituti u Srbiji i regionu će imati model na osnovu kojeg će moći da unaprede svoja znanja. Kada se nekoliko manjih transformacija spoji u jednu, interesovanje zajednice raste na globalnom nivou i na taj način dolazi do izvrsnosti i napretka. Glavni cilj ovog projekta su transformacija i izvrsnost naučnih i tehnoloških saznanja koji će proširiti umrežavanje i saradnju u regionu, ali i u evropskim istraživačkim krugovima. Očekuje se da će projekat uticati na širenje naučnih, ekonomskih i društvenih efekata u podizanju svesti, kao i u pogledu izvrsnosti Instituta za kukuruz, što će u budućnosti otvoriti nove naučne vizije. CREDIT Vibes će dodatno doprineti transformaciji savremenih metoda u istraživanjima, kao i kreiranju novih rešenja za izazove sa kojima će se susretati istraživači u oblasti poljoprivrede, što može biti dugoročni pokretač ekonomskog rasta privrede.

Ključne reči: zdravstveno bezbedna hrana, organska proizvodnja, oplemenjivanje biljaka, inovacije

Zahvalnica: Rad je podržalo Ministarstvo nauke, tehnološkog razvoja i inovacija Republike Srbije, ugovor broj 451-03-9/2021-14/200040 i Evropska komisija kroz projekat TWINNING GREEN-EDITING VIBES FOR FΘΘD, broj 101059942.

MULTI-DISCIPLINARY APPROACH TO INCREASE AGRO-KNOWLEDGE AND AGRO-TECHNOLOGIES IN ORGANIC PRODUCTION

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CREDIT Vibes presents a cloud of Creativity, Research, Education, Development, Innovation, and Transformation (CREDIT) where the training of the highly-skilled researchers and non-research staff is the priority. CREDIT Vibes are launched healthy food/feed, a healthy eco-friendly environment, and healthy life on a healthy planet. It was guided by the idea that if Maize Research Institute from Serbia is structurally transformed and thus improved transfer of agro-technology and agro-knowledge and increase number of manageable projects, other institutions in Serbia and the region will copy that pattern and enhance-self. When several smaller micro-transformations come together, the community's interest rises to the global level, and excellence is born. The main project's objectives are to transform and access excellence following the scientific and technology roadmaps and thus extend networking and collaboration in the region and Europe Research Area. CREDIT Vibes expects broader scientific, economic, and societal effects in raising the excellence of Maize Research Institute, which will open new science pathways and thus increase the number of manageable projects. Furthermore, increasing the transfer of agro-knowledge and agro-technologies into the economy by 15% will be the main long-term propeller of economic growth.

Key words: healthy food and feed, organic farming, plant breeding, innovation

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FERTILNOST KLASAKA U KLASU KOD STRNIH ŽITA

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Fertilnost cveta ima značajnu ulogu u formiranju i razvoju semena i formiranju prinosa semena kod strnih žita. Cilj rada je bio da se izuči variranje fertilnosti klasaka u klasu kod različitih vrsta strnih žita gajenih u samstalnom i združenom usevu sa graškom. U istraživanjima su izučavane ozime forme pšenice (Ilina), tritikale (Odisej), raži (Savo) i ovsa (Jadar) u samostalnom usevu i združenom usevu sa graškom na osnovnim parcelama 5 m^2, u četiri ponavljanja. Ogled je realizovan na oglednom polju Instituta za ratarstvo i povrtarstvo, Instituta od nacionalnog značaja za Republiku Srbiju na Rimskim šančevima kod Novog Sada tokom 2017/18. i 2018/19. vegetacione sezone. Rezultati su pokazali da je broj fertilnih klasaka u klasu bio najmanji u čistom usevu kod pšenice (19,47 i 16,97 fertilnih klasaka), a najveći u združenom usevu kod raži (36, 63 i 41,40 fertilnih klasaka u klasu) i u prvoj i u drugoj vegetacionoj sezoni. Broj fertilnih klasaka po klasu kod raži i ovsa bio je značajno veći u smeši sa graškom nego u samostalnom usevu u obe vegetacione sezone, dok je kod pšenice i tritikalea bio značajno veći u smeši sa graškom nego u samostalnom usevu samo u drugoj vegetacionoj sezoni. Kod izučavanih vrsta strnih žita broj fertilnih klasaka u klasu je bio značajno različit između dve vegetacione sezone osim kod pšenice u združenom usevu, što ukazuje da genotip, sistem setve, ekološki uslovi i inertakcija genotip spoljašnja sredina determinišu vrednost fertilnosti klasaka u klasu.

Ključne reči: genotip, fertilnost, klasak, klas, strna žita

FERTILITY OF SPIKELETS PER SPIKE IN SMALL GRAINS

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Flower fertility plays a significant role in the formation and development of seeds and the formation of seed yield in smal grains. The aim of the work is to study the variation of the fertility of spikelets/spike in different species of small grains grown in a single and mixture crop with peas. In the research, winter forms of wheat (Ilina), triticale (Odisej), rye (Savo) and oats (Jadar) were studied in an independent crop and a mixture crop with peas on basic plots of 5 m^2 in four replications. The experiment was carried out on the experimental field of the Institute for Crop and Vegetable Farming, an Institute of national importance for the Republic of Serbia, at Rimski šančevi near Novi Sad during 2017/18 and 2018/19 growing season. The results showed that the number of fertile spikelets in spike was the lowest in the pure crop with wheat (19.47 and 16.97 fertile spikes) and the highest in mixture crop of rye (36, 63 and 41.40 number of fertile spikelets/spike) both in the first and in the second growing season. Number of fertile spikelets/spike^{-1} in rye and oat was significantly higher in intercrops than in sole crop in both growing season, while in wheat and triticale was significantly higher in intercrops than in sole crop only in second vegetation season. In the studied types of small grains, the number of fertile ears in the ear was significantly different between the two growing seasons, except for wheat in the combined crop, which indicates that the genotype, sowing system, ecological conditions and the interaction between the genotype and the external environment determine the fertility value of the spikelets in the spike.

Key words: genotype, fertility, spikelets, ear, small grain

II-POS-70

VARIJABILNOST GENOTIPOVA KUKURUZA PREMA OŠTEĆENJU STABLA NAPADOM LARVI KUKURUZNOG PLAMENCA (*Ostrinia nubilalis* Hbn.)

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Kod biljaka kukuruza, kukurzni plamenac može naneti velika oštećenja, koja se mogu smanjiti primenom insekticida u zaštiti useva. Cilj istraživanja je da se utvrdi uticaj genotipa kukuruza i insekticida na ukupnu dužinu kanala u stablu nastalog ishranom larvi *Ostrinia nubilalis*. Istraživanje je sprovedeno u Institutu za kukuruz „Zemun Polje" na oglednom polju 2019. godine. U istraživanje su bila uključena tri genotipa kukuruza različitih FAO grupa zrenja (ZP 434, ZP 600 i ZP 666) i tri insekticida: hlorantraniliprol (200 g l-1), bifentrin (100 g l-1) i [lufenuron (50 g l-1)+(cipermetrin (50 g l-1) + hlorpirifos (500 g l-1)], koji su primenjeni 15 dana posle maksimalnog leta prve generacije u svrhu zaštite biljaka od napada kukuruznog plamenca. Rezultati su pokazali da postoje značajne razlike izmedju genotipova kukuruza prema ukupnoj dužini kanala u stablu biljaka, koji su nastali ishranom larvi. Najmanja dužina kanala u stablu je nadjena na tretmanu sa insekticidom hlorantranaliprol kod genotipa kukuruza ZP 600 (181,0067 cm) a najveća na kontrolnoj varijanti (bez primene insekticida) kod istog genotipa kukuruza ZP 600 (316,67 cm). Za sve tretmane, prosečna vrednost ukupne dužine kanala u stablu je bila najmanja 230,00 cm kod ZP 434, nešto veća 241,25 cm kod ZP 600, dok je najveća prosečna vrednost ukupne dužine kanala iznosila 251,66 cm kod genotipa kukuruza ZP 666. Utvrđene razlike za ukupnu dužinu kanala zavisile su od genotipa i vrste primenjenog insekticida.

Ključne reči: dužina kanala, genotip, insekticid, kukuruz, štetočina

VARIABILITY OF MAIZE GENOTYPES ACCORDING TO STEM DAMAGE BY ATTACK OF LARVAE EUROPEAN CORN BORER (*Ostrinia nubilalis* Hbn.)

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In maize plants the attack of European corn borer can cause significant damages, which can be reduced by insecticide application in crop protection. The aim of study was to determine the effect of genotype and insecticides on the total length of channels in maize plant stem formed by the feeding of larvae *Ostrinia nubilalis*. The study was carried out in Maize Research Institute "Zemun Polje" on the experimental field in 2019 vegetation season. For this study we used three maize genotypes of different FAO groups (ZP 434, ZP 600 and ZP 666) and three insecticides chlorantraniliprole (200 g l^{-1}), bifenthrin (100 g l^{-1}) and [lufenuron (50 g l^{-1})+(cypermethrin (50 g l^{-1}) + chlorpyrifos (500 g l^{-1})], which were applied only after the maximum flight of the first generation to protect plants from attack of European corn borer. The results showed that there are significant differences between the maize genotypes according to total length of channels in the stem of plants, which caused by the feeding of larvae European corn borer. The smallest channel length in stem was found on treatment with insecticide chlorantraniliprole in maize genotype ZP 600 (181.67 cm) and the largest on the control variant (without insecticide application) in same maize genotype ZP 600 (278.33 cm). For all treatments, the average value of total length of channels in the stem was the smallest 230.00 cm in ZP 434, slightly higher 241.25 cm in ZP 600, while the highest average value of total length of channels was 251.66 cm in maize genotype ZP 666. The determined differences for total length of the channels depended on genotype and type of insecticide applied.

Key words: genotype, maize, pest, insecticide, length of channels.

III tematska oblast / Topic III

Savremeni trendovi u oplemenjivanju drveća, voćaka i vinove loze

Contemporary trends in the breeding of trees, fruit trees and vines

III-PP-01

GENETIČKI DIVERZITET HRASTA KITNJAKA IZ JUGOISTOČNIH I SREDNJEEVROPSKIH PROVENIJENCIJA

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Hrast kitnjak (*Q. petreae*), je ekološki i ekonomski značajna listopadna šumska vrsta drveća u Evropi. Pretežno je rasprostranjen u zapadnoj, srednjoj i južnoj Evropi, uglavnom u brdskim i planinskim šumama. U kontekstu klimatskih promena, rasprostranjenost hrasta kitnjaka je pod pritiskom na zapadnoj i južnoj granici areala. Ali i u istočnoj i jugoistočnoj Evropi hrast kitnjak bi mogao da dostigne svoju klimatsku granicu, verovatno zbog sve jačih kontinentalnih klimatskih uslova. Hrast kitnjak imaja veliku genetičku varijabilnost u jugoistočnoj Evropi, gde su se primarne i sekundarne refugije nalazile tokom poslednje glacijacije. Međutim, adaptivna genetička varijabilnost populacija u ovom regionu je samo delimično istražena, iako bi bila veoma koristan alat za sprovođenje asistirane migracije i za potencijalno *ex-situ* očuvanje ugroženih populacija. U okviru istraživanja testira se 65 jugoistočnih i srednjeevropskih provenijencija hrasta kitnjaka. U različitim ekološkim uslovima, u najmanje šest evropskih zemalja, je planirano uspostavljanje provenijeničnih testova. Istraživanje će obuhvatiti analize preživljavanja sadnica godinu dana nakon sadnje kao i preživljavanja sadnica i praćenje elemenata rasta tri, pet, deset i dvadeset godina nakon sadnje. Dodatno će se pratiti fenološke pojave tokom prolećnog i jesenjeg perioda vegetacije. Dobijeni podaci će poslužiti za razvoj različitih linearnih i mešovitih statističkih modela za odvajanje efekta porekla od drugih izvora varijabilnosti. Cilj istraživanja je bolje razumevanje adaptivnog genetičkog diverziteta hrasta kitnjaka u jugoistočnoj i srednjoj Evropi u odnosu na klimu porekla i očekivane buduće klimatske uslove.

Ključne reči: hrast kitnjak, adaptivni potencijal, klimatske promene, poreklo.

Zahvalnica: Ovaj rad je realizovan u okviru Ugovora o realizaciji i finansiranju naučnoistraživačkog rada NIO u 2023. godini, koje finansira Ministarstvo nauke, tehnološkog razvoja i inovacije Republike Srbije, br. 451-03-47/2023-01/200027.

GENETIC DIVERSITY OF SESSILE OAK FROM SOUTHEASTERN AND CENTRAL EUROPEAN PROVENANCES

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Sessile oak (*Q. petreae*) is an ecologically and economically significant European deciduous forest tree species. It is mainly distributed in hilly and mountain forests of Western, Central, and Southern Europe. With climate change, the sessile oak distribution is under pressure in the Western and Southern distribution areas. Also, the sessile oak might reach its climate limit in Eastern and Southeastern Europe, probably due to increasing continental climate conditions. Sessile oak has high genetic variation in Southeastern Europe, where primary and secondary refugia were located during the last glaciation. However, the adaptive genetic variability of populations in this region is only partially researched, even though it would help conduct assisted migration schemes and potential ex-situ conservation of endangered populations. As part of the research, 65 Southeastern and Central European provenances of sessile oak will be tested. The provenance tests will be established in at least six European countries with various environmental conditions. The research will cover the analyses of seedling survival one year after planting and seedling survival and growth elements three, five, ten, and twenty years after planting. Additionally, phenological observations will be conducted during the spring and autumn growing seasons. The obtained data will develop various linear and mixed models to separate provenance effects from the other sources of variation. The research objective is a better understanding of the adaptive genetic diversity of sessile oak in Southeastern and Central Europe concerning the climate of provenance origin and expected future climate conditions.

Key words: Sessile oak, adaptive potential, climate change, origin.

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III-PP-02

OPLEMENJIVANJE KOŠTIČAVIH VRSTA VOĆAKA SA ASPEKTA BIOLOGIJE CVETANJA – DOSTIGNUĆA I BUDUĆI PRAVCI

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Značajan napredak u oplemenjivanju koštičavih vrsta voćaka ostvaren je širom sveta, u cilju dobijanja novih sorti prilagođenih različitim agro-ekološkim uslovima, sa karakteristikama koje obezbeđuju komercijalne efekte i odgovaraju zahtevima potrošača u pogledu kvaliteta i zdravstvene bezbednosti plodova. Istraživanja reproduktivne biologije predstavnika roda *Prunus*, korišćenjem različitih metodologija (molekularnih, bioloških, histoloških), obezbedila su značajne informacije o biološkim događajima bitnim za zametanje plodova. Različiti aspekti koji se odnose na vreme cvetanja, potrebu za oprašivačima, muški i ženski gametofit, njihove performanse i interakcije (koje su u osnovi reproduktivnog uspeha) u različitim ekološkim kontekstima, pokazali su se kao veoma bitne teme od značaja za strategije oplemenjivanja i stvaranje novih sorti. Pokazalo se da su određene genetički determinisane reproduktivne osobine, kao što su kratko vreme cvetanja i životni vek ovula kao i, posledično, kratak efektivni polinacioni period, samobesplodnost, za modernu hortikulturnu praksu manje poželjne ili nepoželjne. Rezultati pokazuju da aktuelne klimatske promene imaju negativni uticaj na produkciju plodova u voćarstvu. Razmatrajući sadašnju situaciju kao osnov za budući razvoj u oblasti oplemenjivanja i proizvodnje plodova koštičavih vrsta voćaka, neophodni su dalji integrativni pristupi. Novi ciljevi oplemenjivanja vrsta roda *Prunus* moraju objediniti adaptabilnost na temperaturne okolnosti koji proističu iz klimatskih promena, kvalitet ploda i otpornost na bolesti. U tom smislu, proučavanje fiziologije reproduktivnih procesa u narednim godinama će postajati sve značajnije, iz perspektive suočavanja sa promenama uslova životne sredine.

Ključne reči: koštičave vrste voćaka, reproduktivna biologija, karakteristike cveta

Zahvalnica: Ovo istraživanje je finansiralo Ministarstvo prosvete, nauke i tehnološkog razvoja Republike Srbije (broj ugovora 451-03-47/2023-01/200215) i Fond za nauku Republike Srbije (broj ugovora 7739716 – CherrySeRB).

STONE FRUIT BREEDING WORK FROM THE ASPECT OF THE FLORAL BIOLOGY – ACHIEVEMENTS AND FUTURE DIRECTIONS

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Considerable progress has been made in the breeding of stone fruits worldwide, in order to obtain cultivars that are adapted to different agro-ecological conditions, and with characteristics that ensure commercial effects and respond to consumer demands for healthy and quality fruits. Studies of the reproductive biology of *Prunus* species have combined different methodologies (molecular, biological, histological), providing valuable information on biological events essential for optimal fruit set. Different aspects related to blooming time, the needs for pollenisers, male and female gametophytes, their performances and interactions (that underlie reproductive success) under various ecological contexts, were shown to be important topics that contribute to the breeding strategies and developing of the new cultivars. Genetically determined reproductive traits such as short blooming time or ovule longevity and, consequently, insufficient effective pollination period, and self-incompatibility, have been shown to be less desirable or unsuitable from the aspect of modern horticultural practice. Nowadays, results also indicate that ongoing climate change has detrimental effects on fruit production. Considering different aspect of the current situation as a baseline for the future development of the stone fruits breeding and production, the future integrative approaches are necessary. The new breeding objectives of *Prunus* species must unify adaptability to temperature conditions arising from climate change, fruit quality and disease resistance. In this regard, the study of the physiology of reproductive processes will become increasingly important in future years from the perspective of coping with such environmental changes.

Key words: stone fruits, reproductive biology, flower characteristics

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III-PP-03

OPLEMENJIVANJE BAŠTENSKIH RUŽA U CILJU POSTIZANJA ODRŽIVOG RAZVOJA

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Baštenske ruže (*Rosa* × *hybrida* L.) su među omiljenim ukrasnim biljkama, rezanim i saksijskim cvećem, koje se uzgaja na obe hemisfere i na pet kontinenata. Zahvaljujući dugotrajnoj kompleksnoj prirodnoj i veštačkoj, unutarvrsnoj i međuvrsnoj hibridizaciji, nastali su brojni kultivari, različitih boja i oblika cvetova, kao i različitih mirisnih nota. Danas, sa razvojem ekološke svesti, tržište se orijentiše ka zdravim biljkama koje zahtevaju što manju primenu pesticida. To je jedan od razloga zašto se danas u oplemenjivanju ruža najviše pažnje posvećuje otpornosti na bolesti, otpornosti na niske i visoke temperature, ili ekstremnim uslovima staništa. Oplemenjivanje baštenskih ruža je proces koji se nikada ne završava, a ciljevi uzgoja se danas pomeraju od čisto estetskih ka ekološki prihvatljivijim, pružajući različite ekosistemske usluge i usklađujući se sa ciljevima održivog razvoja. Usmereno oplemenjivanje rezultiralo je sa nekoliko kolekcija ruža, od kojih je svaka jedinstvena i pogodna za postizanje jednog ili više ciljeva održivog razvoja. Novostvoreni kultivari kompanije 'Pheno Geno Roses' iz Srbije kombinuju više osobina koje ih čine pogodnim za održivo ozelenjavanje javnih i privatnih prostora. Većina kultivara iz predstavljenih kolekcija ('Mella', 'Frayla' 'Aurora', 'Fashion', 'Reka', 'Pixi' i 'Winterjewel') poseduje tolerantnost na glavne prouzrokovače bolesti (omogućavajući proizvodnju i održavanje sa značajno smanjenom primenom pesticida), atraktivan izgled biljke i boju cveta, izražen miris i jednostavne zahteve uzgajanja. Pored navedenih, cilj ovog istraživanja bio je da se odaberu superiorniji genotipovi kroz biohemijski usmerenu selekciju ka dodatoj vrednosti – jestivim laticama sa visokim ukupnim sadržajem fenola, ukupnim sadržajem flavonoida, ukupnim sadržajem monomernih antocijanina, vitamina C, kininske kiseline i 44 odabranih fenolnih jedinjenja (14 fenolnih kiselina, 25 flavonoida, 3 kumarina i 2 lignana). Budući programi oplemenjivanja ruža treba da uzmu u obzir višestruku dodatu vrednost kroz izbor kultivara koji su i ukrasni i jestivi, istovremeno zadovoljavajući nekoliko važnih društvenih potreba.

Ključne reči: oplemenjivanje na otpornost, unapređenje kultivara, sigurnost obezbeđenja hrane, ornamentalna vrednost, održivo oplemenjivanje ruža, konvencionalno oplemenjivanje

Zahvalnica: Istraživanje je sprovedeno u okviru četvorogodišnjeg projekta pod nazivom Biohemijski usmerena selekcija baštenskih ruža u cilju povećanja kvaliteta i tržišne kompetitivnosti vojvođanskih proizvođača, broj 142-451-3153/2022-01/01, finansiran od strane Pokrajinskog sekretarijata za visoko obrazovanje i naučnoistraživačku delatnost, Autonomna Pokrajina Vojvodina, Republika Srbija.

BREEDING GARDEN ROSES TO MEET SUSTAINABLE DEVELOPMENT GOALS

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Garden roses (*Rosa* × *hybrida* L.) are amongst the favorite landscaping, cut and potted ornamental plants, cultivated on both hemispheres and five continents. Owing to the long-term complex natural and artificial intra and interspecific hybridization, numerous varieties have appeared, with different flower colors and shapes, as well as various scent notes. Today, with the development of environmental awareness, the market demands healthy plants requiring as little use of pesticides as possible. This is one of the reasons why today in rose breeding most attention is paid to disease resistance, resistance to low and high temperatures, or extreme habitat conditions. Breeding garden roses is a process that never ends and breeding goals nowadays are shifting from merely aesthetic towards more environmentally and wildlife friendly, providing urban ecosystem services and aligning with Sustainable Development Goals (SDGs). Streamlined novel breeding has resulted in several rose collections, each unique and suitable for achieving one or several SDGs. Newly bred cultivars at the 'Pheno Geno Roses' company in Serbia combine multiple traits that make them suitable for sustainable landscaping. The majority of the cultivars from presented collections ('Mella', 'Frayla' 'Aurora', 'Fashion', 'Reka', 'Pixi' and 'Winterjewel') possess tolerance to major diseases (enabling the production and maintenance with significantly reduced pesticide application), attractive plant appearance and colors, pronounced fragrance and simple requirements (thus being easy to grow). Besides listed, the goal of this research was to select the advanced genotypes that have added edible value through the biochemically driven selection for traits such as total phenolic content, total flavonoid content, total monomeric anthocyanin content, vitamin C, the content of quinic acid and 44 selected phenolic compounds (14 phenolic acids, 25 flavonoids, 3 coumarins and 2 lignans). Future rose breeding plans should consider multiple added values through the selection of cultivars that are both ornamental and edible, concomitantly meeting several important societal needs.

Key words: breeding for resistance, cultivar improvement, food security, Ornamental value, sustainable rose breeding, traditional breeding

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III-POS-04

SELEKCIJA GENOTIPOVA POLJSKOG BRESTA NA PODRUČJU PIO "KOSMAJ" KAO OSNOVA ZA NAMENSKU PROIZVODNJU SADNOG MATERIJALA VEGETATIVNIM PUTEM

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Poljski brest (*Ulmus minor* Mill.) je vrsta koja u šumskom fondu Republike Srbije spadau kategoriju retkih/ugroženih vrsta čija je brojnost znatno smanjena kao posledica holandske bolesti koja je prisutna na području čitave Evrope poslednjih decenija. Smanjenjem autohtone populacije poljskog bresta, šumarstvo je lišeno njegovih dragocenih ekonomskih i meliorativnih vrednosti, a pejzažna arhitektura uskraćena za upotrebu poljskih brestova u oplemenjivanju urbanih sredina i vangradskih predela. Na prostoru predela izuzetnih odlika (PIO) „Kosmaj" poljski brest je autohtona vrsta, čija je brojnost znatno redukovana, a populacija svedena na neštomanje od 100 stabala kod kojih, u dužem vremenskom periodu, nije konstatovan urod. Procenjena starost stabala, njihovo zdravstveno stanje, nedostatak prirodnog podmlađivanja i plodonošenja kao i veliki broj faktora koji dovode do genetičke erozije raspoloživog genofonda upućuju na potrebu namenske proizvodnje sadnog materijala vegetativnim putem. U tom cilju obavljena je selekcija 12 materinskih stabala, na osnovu fenotipskih karakteristika i zdrvastvenog stanja, sa kojih su sakupljene grančice od kojih su formirane reznice. U staklari Šumarskog fakulteta, osnovan je klonski test potomstva u kome je tokom tri meseca praćen procenat prijema i preživljavanja reznica kao i uticaj debljine reznica na njihovo ožiljavanje. Procenat preživljavanja se na kraju istraživanja kretao od 0,00% do 49,12% u zavisnosti od materinskog stabla, a prosečan prečnik na sredini reznice za sva materinska stable iznosio je 3,58 mm. Dobijeni rezultati poslužiće kao osnova za masovnu proizvodnju sadnog materijala za potrebe konzervacije i održivog korišćenja genofonda poljskog bresta na ovom području.

Ključne reči: *Ulmus minor*; retke/ugrožene vrste; klonski test potomstva; reznice; konzervacija genofonda

SELECTION OF FIELD ELM GENOTYPES IN THE AREA OF "KOSMAJ" AS A BASIS FOR THE DEDICATED PRODUCTION OF VEGETATIVE PLANTING MATERIAL

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Field elm (*Ulmus minor* Mill.) is a species that belongs to the category of rare/endangered species in the forest fund of the Republic of Serbia. Its population has been significantly reduced as a result of the Dutch elm disease, which has been present throughout Europe in recent decades. By reducing the autochthonous population of field elm, forestry is deprived of its valuable economic and melioration values, and landscape architecture is deprived of the use of field elms in the refinement of urban environments and suburban areas. In the natural protected area "Kosmaj" fieldelm is an autochthonous species, whose number significantly decreased and the population was reduced to less than 100 trees, where, for a long period of time, no crop was recorded. The estimated age of the trees, their state of health, the lack of natural rejuvenation and fruiting, as well as a large number of factors that lead to the genetic erosion of the available gene pool indicates the need for dedicated production of vegetative planting material. This research aimed to select 12 mother trees, based on phenotypic characteristics and health status, from which twigswere collected and were used to form cuttings. In the glasshouse of the Faculty of Forestry, a clonal progeny test was established in which, on a monthly basis, the percentage of rooting and survival of cuttings was monitored, as well as the thickness influence of the cuttings to root formation. The percentage of survival at the end of the research ranged from 0.00% to 49.12% depending on the mother tree, and the average diameter in the middle of the cutting for all mother trees was 3.58 mm. The obtained results will serve as a basis for the mass production of planting material for the purposes of conservation and sustainable use of the field elm gene pool in this area.

Key words: *Ulmus minor*; rare/endangered species; clonal progeny test; cuttings; gene pool conservation

III-POS-05

VARIJABILNOST MORFOLOŠKIH KARAKTERISTIKA LISTOVA DIVLJE KRUŠKE (*Pyrus pyraster* (L.) Burgsd.) NA PODRUČJU PIO „KOSMAJ“

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Divlja kruška je na prostoru Srbije autohtona vrsta drveća koja je svrstana u kategoriju vrsta „pod rizikom“. Hibridizacija sa kultivarima koji se uzgajaju za proizvodnju voća je veomačesta, što otežava identifikaciju čistih divljih voćkarica i predstavlja jedan od ugrožavajućih faktora koji dovode do genetičke erozije autohtonog genofonda. Cilj rada je utvrđivanje unutarpopulacione varijabilnosti selekcionisanih test stabala divlje kruške na području Predela izuzetnih odlika „Kosmaj“, kao osnove za konzervaciju raspoloživog genofonda. Listovi su sakupljeni sa 16 test stabala selekcionisanih na području Kosmaja (100 listova po stablu), na kojima su analizirani sledeći kvantitativni i kvalitativni parametri: dužina lisne ploče, maksimalna širina lista, dužina lisne ploče od osnove lista do dela na kome je merena maksimalna širina, dužina peteljke, ugao vrha lista, ugao osnove lista, površina lisne ploče, obim lisne ploče, odnosno oblik lista, oblik osnove lista, oblik vrha lista, obod lista. Sakupljeni listovi (ukupno 1600) su herbarizovani, skenirani i izmereni pomoću softvera *ImageJ*, dok je statistička obrada podataka urađena pomoću softvera *Statgraphics Centurion XVII* i *Statistica 6.0*. Materinsko stablo 35 se izdavaja u odnosu na druga na osnovu dobijenih prosečnih vrednosti kvantitativnih parametara, dok se materinsko stablo 27 izdvaja na osnovu kvalitativnih parameter. Rezultati istraživanja pokazali su da su sve dobijene vrednosti statistički značajne ($p < 0,05$), što ukazuje na postojanje zadovoljavajućeg stepena genetičke varijabilnosti između ispitivanih stabala, koji predstavlja dobru osnovu za očuvanje i usmereno korišćenje genofonda ove vrste.

Ključne reči: *Pyrus pyraster* (L.) Burgsd., konzervacija genofonda, varijabilnost, morfološke karakteristike, listovi

VARIABILITY OF MORPHOLOGICAL CHARACTERISTICS OF WILD PEAR (*Pyrus pyraster* (L.) Burgsd.) LEAVES IN THE NATURAL PROTECTED AREA"KOSMAJ"

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The wild pear is an autochthonous tree species on the territory of Serbia, which is classified as "at risk" species. Hybridization with cultivars grown for fruit production is very common, which makes it difficult to identify pure wild fruit trees and is one of the threatening factors that lead to the genetic erosion of the indigenous gene pool. The aim ofthis research is to determine the intra-population variability of the selected wild pear test treesin the Natural protected area "Kosmaj", as a basis for the conservation of the available gene pool. Leaves were collected from 16 test trees selected in the area of Kosmaj (100 leaves per tree), on which the following quantitative and qualitative parameters were analyzed: leaf blade length, maximum leaf width, leaf blade length from the base of the leaf to the part where the maximum width was measured, petiole length, leaf tip angle, leaf base angle, leaf blade area, leaf blade circumference, i.e. leaf shape, leaf base shape, leaf tip shape, leaf margin. Collected leaves (1600 in total) were herbarized, scanned and measured using *ImageJ* software, while statistical data processing was done using *Statgraphics Centurion XVII* and *Statistica 6.0* software. Mother tree 35 is distinguished from others based on the obtained average values of quantitative parameters, while mother tree 27 is distinguished based on qualitative parameters. The results of this research showed that all obtained values are statistically significant ($p < 0.05$), which indicates the existence of a satisfactory degree of genetic variability between the examined trees, which represents a good basis for the conservation and targeted use of the gene pool of this species.

Key words: *Pyrus pyraster* (L.) Burgsd., gene pool conservation, variability, morphological characteristics, leaves

III-POS-06

UTICAJ BAKTERIJSKIH TRETMANA NA VREDNOSTI SPAD INDEKSA LISTOVA SADNICA HRASTA KITNjAKA (*Quercus petraea* (Matt.) Liebl)

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Bakterije koje promovišu rast biljaka (eng. *Plant Growth Gromoting Bacteria*, PGPB) predstavljaju raznovrsnu grupu mikroorganizama koje poboljšavaju performanse biljaka, pomažu rast i prevazilaženje šoka presađivanja. Efekat PGPB na fiziologiju i morfologiju drvenastih vrsta u uslovima Srbije nije istražen. Hrast kitnjak je autohtona, ekološki i ekonomski veoma cenjena vrsta u šumarstvu Srbije. Njegove šume se poslednjih decenija suočavaju sa fiziološkim problemima koji dovode do sušenja, pa je izražena potreba za veštačkom obnovom i sadnicama koje će se uspešno adaptirati i integrisati u novu sredinu. U radu je ispitivan efekat 2 bakterijska izolata iz rizosfere prirodnih kitnjakovih sastojina – *Viridibacillus arvi*R3.17 i *Pseudomonas koreensis*R4.2.1P, na količinu hlorofila u listovima jednogodišnjih sadnica kitnjaka iz 3 srpske provenijencije – Rudnik, Grabova reka i Rogozna. Merenja su vršena SPAD hlorofilmetrom na uzorku od 10 biljaka po tretmanu, tri puta u toku vegetacionog perioda – junu, avgustu i oktobru. SPAD indeksi analizirani su primenom ANOVA i Tukijevog testa. Vrednosti SPAD jedinica rastu od početka ka sredini vegetacionog perioda i smanjuju u oktobru. Najveća srednja vrednost, 39,8, izmerena je u junu kod biljaka tretiranih *P. koreensis* R4.2.1P izolovanom iz rizosfere kitnjaka, iz provenijencije Grabova reka. Najmanja srednja vrednost, 30,0, zabeležena je u oktobru, u grupi biljaka tretiranih *V. arvi*R3.17 izolovanom iz rizosfere kitnjaka, iz provenijencije Rogozna. Takođe, postoje statistički značajne razlike između tretmana izolatom *V. arvi*R3.17 u odnosu na kontrolne tretmane svih provenijencija u avgustu i oktobru. Dobijeni preliminarni rezultati ohrabruju dalje izučavanje PGPB u kontekstu drvenastih vrsta, ali je neophodno pratiti uticaj na većem broju jedinki.

Ključne reči: bakterije, kitnjak, hlorofil

Zahvalnica: Istraživanje je sprovedeno na osnovu Ugovora o realizaciji i finansiranju naučnoistraživačkog rada NIO u 2023. godini, koji je zaključen sa Ministarstvom nauke, tehnološkog razvoja i inovacija Republike Srbije, pod evidencionim brojem 451-03-47/2023-01/ 200027.

INFLUENCE OF BACTERIAL TREATMENT ON LEAF SPAD VALUE OF SESSILE OAK (*Quercus petraea* (Matt.) Liebl) SEEDLINGS

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Plant Growth Promoting Bacteria (PGPB) represent a diverse group of microorganisms that improve plant performance, help growth, and overcome transplantation shock. The effect of PGPB on the physiology and morphology of woody species in Serbian conditions has not been investigated. The sessile oak is an autochthonous, ecologically and economically highly valued species in Serbian forestry. In recent decades, its forests have been facing physiological problems that lead to drying, so there is a need for artificial reforestation and seedlings that will successfully adapt and integrate into the new environment. The paper examined the effect of 2 bacterial isolates from the rhizosphere of natural sessile oak stands – *Viridibacillus arvi*R3.17 and *Pseudomonas koreensis*R4.2.1P - on the amount of chlorophyll in the leaves of one-year sessile oak seedlings from 3 Serbian provenances - Rudnik, Grabova reka and Rogozna. Measurements were made with a SPAD chlorophyll meter on a sample of 10 plants per treatment, three times during the growing season - June, August and October. The SPAD indexes were analyzed using ANOVA and Tukey's test. SPAD units increased from the beginning to the middle of the growing season and decreased in October. The highest mean value, 39.8, was in June in plants treated with *P. koreensis*R4.2.1P isolated from the rhizosphere of sessile oak, from the Grabova reka provenance. The lowest value, 30.0, was recorded in October in the group of plants treated with the *V. arvi*R3.17 isolated from the rhizosphere of sessile oak, from the Rogozna provenance. Also, there are statistically significant differences between the treatments with the *V. arvi*R3.17 isolate compared to the control treatments of all provenances in August and October. The obtained preliminary results encourage further study of PGPB in the context of woody species, but monitoring the impact on a larger number of individuals is necessary.

Key words: bacteria, sessile oak, chlorophyll

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IV tematska oblast / Topic IV

Savremeni trendovi u oplemenjivanju životinja i mikroorganizama

Contemporary trends in the breeding of animals and microorganisms

IV-PP-01

IZAZOVI I PROBLEMI U PRIMENI GENOMSKE SELEKCIJE U STOČARSKOJ PROIZVODNJI U SRBIJI

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Genomska selekcija u stočarstvu predstavlja odabir roditelja novih generacija životinja na osnovu njihove DNK strukture, odnosno na osnovu prisustva željenih genskih alela i njihovih interakcija, koji zajedno indukuju određene vrednosti osobina kod domaćih životinja. Ovakav vid selekcije je pandam progenom i performans testu, sa tim što se primenom genomike značajno skraćuje vreme dobijanja informacija o priplodnoj vrednosti životinja. Da bi se primenio odabir jedinki na osnovu njihovog genoma mora postojati dovoljno velika genetski mapirana populacija u kojoj se sprovodi selekcija, a za to je potrebno da se identifikovani aleli iz DNK strukture dovedu u vezu sa određenim nivom proizvodnje. Nadalje, kontinuiran evolutivni proces konstantno dovodi do mutacija i nastanka novih kombinacija alela pa je neophodno kontinuirano ažurirati informacije između DNK strukture i ostvarenih kvantitativnih vrednosti osobina. Uzimajući u obzir goveda i svinje kao vrste kod kojih je genomska selekcija najviše eksploatisana, tačnost između priplodne vrednosti jedinke ocenjene na osnovu DNK strukture i priplodne vrednosti ocenjene na osnovu kvantitativnih vrednosti osobina kreće se u intervalu od 55 do 75%. Primena genomske selekcije u stočarstvu Republike Srbije je na jako niskom nivou jer ne postoji praktična primena procene priplodne vrednosti životinja bilo genomske bilo konvencionalne, iako je to zakonski obavezno i formalno se primenjuje. Sa druge strane većina plemenitih rasa domaćih životinja ima blisko srodstvo sa životinjama iz zemalja gde se ovakav vid selekcije primenjuje zbog stalnog uvoza najčešće priplodnjaka, pa se može reći da je realan uticaj genomske selekcije u domaćim populacijama na neki način indirektan. Takođe, određene inostrane kompanije u Srbiji nude proizvođačima uslugu utvrđivanja genetskog potencijala njihovih životinja na osnovu rezultata mapiranih inostranih populacija, što sve utiče da dobijeni rezultati ne mogu biti kredibilni za domaću proizvodnju. Identifikovani aleli samo u određenim uslovima (mapirana populacija) uslovljavaju predstavljenu vrednost osobina, pa shodno tome dobijene genomske vrednosti na ovakav način mogu biti samo relevantne za populacije životinja na osnovu kojih su dobijene, ali ne i za domaću populaciju. Prilikom genetskog mapiranja populacija dok se ne dobije dovoljno reprezentativan obim informacija o specifičnom delovanju alela treba koristiti rezultate inostranih populacija, ali ih treba ispitati u domaćim proizvodnim uslovima i potvrditi ili odbaciti njihovo delovanje u domaćim populacijama životinja.

Ključne reči: genomska selekcija, priplodna vrednost, genetsko mapiranje populacije.

Zahvalnica: Rad je sastavni deo projekta 451-03-47/2023-01/200116 finansiranog od strane Ministarstva nauke, tehnološkog razvoja i inovacija Republike Srbije.

CHALLENGES AND ISSUES IN THE USE OF GENOMIC SELECTION IN LIVESTOCK BREEDING IN SERBIA

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Genomic selection in livestock production implies selection of parents of new animal generations on the basis of their DNAstructure, i.e. on a presence of desired gene alleles and their interactions which together can induce certain values in domestic animals` traits. When this type of selection is in question it can be said that it is a counterpart to progeny and performance tests which are still in use while the use of genomics can significantly reduce the time of obtaining information regarding an animal breeding value. In order to use individual selection based on individual`s genome there must be a sufficiently large genetically mapped population in which this mode of selection is being conducted for which it is necessary that identified alleles from DNA structure be brought into connection with a certain level of production. Furthermore, a continuous evolutionary process constantly leads to mutations and creation of new combinations of alleles, thus it is necessary to continually update information between DNA structure and realized quantitative trait values. Taking into account cattle and pigs as species in which genomic selection has been the most exploited the exactness between breeding value of an individual estimated on the basis of DNA structure and breeding value estimated on the basis of realized quantitative values of the traits lays in the interval of 55 to 75%. The use of genomic selection in livestock breeding in the Republic of Serbia is on a very low level, because in Serbia there is no practical application of estimation of animal breeding value either genomic or ordinary even though it is legally required and formally enforced. On the other hand, majority of noble breeds of domestic animals has a close relation with animals from the countries in which this kind of selection is being applied due to constant frequent import of breeding males so it can be said that real effect of genomic selection in domestic populations is in a way an indirect one. In addition, certain foreign companies in Serbia provide to producers the service of determining the genetic potential of their animals on the basis of the results of mapped foreign populations what makesthe results obtained not to be credible for domestic production. Identified alleles can affect presented value of the traits in specific conditions only (mapped population) and therefore the genomic values obtained in this way can be relevant only for populations of animals on the basis of which they have been obtained but not for domestic populations as well. When doing genetic mapping of populations until a sufficiently representative volume of information on specific action of alleles has not been obtained we should use the results from foreign populations but they should be investigated in domestic production conditions and their action in domestic populations of animals either confirmed or rejected.

Key words: genomic selection, breeding value, population genetic mapping.

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V tematska oblast / Topic V

Semenarstvo i prikaz novih sorti

Seed production and new varieties presentations

V-PP-01

RAZVOJ SEMENARSTVA U SRBIJI: DOKLE SMO STIGLI

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Proizvodnja kvalitetnog semena najboljih sorti i hibrida od izuzetnog je značaja za svaku državu. Na prostorima današnje Srbije proizvodnja semena je prolazila kroz različite etape razvoja. Formiranjem Kraljevine Srbije došlo je do malog pomaka u proizvodnji semena njivskih biljaka, to je bilo krajem XIX veka kada su osnovane poljoprivredne ogledne i kontrolne stanice. Uloga ovih stanica je bila da se seljaci upoznaju sa potencijalima rodnosti tada dostupnih genotipova biljaka. Uglavnom se radilo o lokalnim populacijama. Posle završetka I svetskog rata došlo je do ujedinjenja više teritorija sa više formiranih oglednih stanica čija je uloga bila da se upoznaju seljaci sa kvalitetnim semenom. Posle II svetskog rata došlo je do razvoja oplemenjivanja na savremenim osnovama genetike čiji rezultati su bili vidljivi već 60-tih godina prošlog veka. Sa razvojem oplemenjivanja biljaka i stvaranjem domaćih oplemenjenih sorti došlo je do osnivanja prvih savremenih doradnih centara za doradu semena raznih njivskih biljaka. Tih godina Srbija je bila jedna od vodećih zemalja u Evropi po proizvodnim površinama i proizvedenim količinama kvalitetnog sortnog semena. Ovaj zlatni period u razvoju semenarstva prekinut je prelaskom sa socijalističke privrede na neoliberalni privredni sistem. Mnoge semenske kuće sa svojim doradnim kapacitetima su prošle razne transformacije. Neke od semenskih kuća su prestale da rade osnovni posao zbog koga su nastale, prestale su da proizvode seme. Druge semenske kuće su privatizovane, ali su kapaciteti za doradu i skladištenje semena slabo iskorišćene. Neke od semenskih kuća koriste svoje kapacitete sa 30%. Kakva je budućnost semenarstva u Srbiji? Mora doći do ozbiljnih naučnih i stručnih rasprava i dogovora kako bi se semenarstvo u Srbiji unapredilo. Moraju se doneti nova zakonska i podzakonska akta koja će osigurati da se proizvodi kvalitetno, genetski čisto seme. Uloga države, instituta, semenskih kuća i proizvođača semena je izuzetno velika u ovoj oblasti ako se želi unaprediti semenarstvo.

Ključne reči: nacionalno zakonodavstvo, perspective, proizvodnja semena

DEVELOPMENT OF SEED PRODUCTION IN SERBIA: HOW FAR WE HAVE COME

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The production of quality seeds of the best varieties and hybrids is extremely important for every country. In today's Serbia, seed production went through various stages of development. With the formation of the Kingdom of Serbia, there was a small shift in the production of field plant seeds, that was at the end of the 19th century when agricultural experimental and control stations were established. The role of these stations was to familiarize the farmers with the potential of the then available plant genotypes. It was mostly about local populations. After the end of the First World War, there was a unification of several territories with several formed experimental stations whose role was to introduce the farmers with quality seeds. After World War II, there was a development of breeding on the modern basis of genetics, the results of which were already visible in the 60s of the last century. With the development of plant breeding and the creation of domestically bred varieties, the first modern processing centers for seed processing of various field plants were established. In those years, Serbia was one of the leading countries in Europe in terms of production areas and produced quantities of quality varietal seeds. This golden period in the development of seed production was interrupted by the transition from a socialist economy to a neoliberal economic system. Many seed companies with their processing capacities have undergone various transformations. Some of the seed houses have stopped doing the basic work for which they were created, they have stopped producing seeds. Other seed houses were privatized, but the capacities for processing and storing seeds were poorly used. Some of the seed companies use their capacities with 30%. What is the future of seed production in Serbia? There must be serious scientific and professional discussions and agreements in order to improve seed production in Serbia. New laws and rules must be passed to ensure that quality, genetically pure seeds are produced. The role of the state, institutes, seed companies and seed producers is extremely important in this area if seed production is to be improved.

Key words: national legislation, perspectives, seed production

V-PP-02

ISPITIVANJE GENETIČKE UNIFORMNOSTI SEMENA: OD POLJA, PREKO LABORATORIJE DO VEŠTAČKE INTELIGENCIJE

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Ispitivanjem genetičke čistoće se utvrđuje autentičnost, originalnost, kao i stepen kontaminacije semenom nepoželjnih genotipova iste vrste u uzorku. Uspešna proizvodnja hibridnog semena zavisi od genetičke čistoće roditeljskih komponenti. Procena genetičke originalnosti, uniformnosti i stabilnosti postiže se primenom različitih vrsta markera: morfoloških, biohemijskih i molekularnih. Pristup zasnovan na morfološkim markerima, poljski ogledi (GOT- Grow Out Test), se i u današnje vreme najčešće koristi u navedene svrhe. U poljskim ogledima se koristi set osobina „deskriptora" koji u mnogim zemljama predstavlja neophodan zahtev za kontrolu genetičke čistoće partija semena i sertifikaciju hibrida kukuruza. Procena morfoloških markera je dugotrajan posao koji zavisi od uslova spoljne sredine i obučenosti ljudi koji prikupljaju podatke. Biohemijski markeri, rezervni proteini semena i izoenzimi, omogućavaju brzu i preciznu procenu uniformnosti genotipova kukuruza, i nisu pod uticajem uslova spoljne sredine. Ipak njihovom primenom se uvek ne dobijaju pouzdani rezultati pri ispitivanju genetički srodnih genotipova kukuruza. Molekularni markeri, zasnovani na varijacijama u DNK sekvencama (SSR) ili polimorfizmu pojedinačnih nukleotida (SNP), osim veće efikasnosti i pouzdanosti predstavljaju nepristrasan alat za analizu genetičke čitoće i autentičnosti. Primena ovih markera zahteva velika ulaganja u opremu, optimizaciju metoda i osposobljavanje stručnih analitičara. Poslednjih godina se istražuje mogućnost primene veštačke inteligencije u ispitivanju autentičnosti i uniformnosti inbred linija i hibrida kukuruza. Na osnovu procesuiranja slika morfologije semena i hiperspektralne refleksije koja daje podatke o hemijskom sastavu semena razvijaju se precizne, efikasne i nedestruktivne metode za identifikaciju genetički i fenotipski srodnih genotipova. Prezentacija će dati detaljniji uvid u primenu navedenih metoda za ispitivanje genetičke čistoće semena kukuruza.

Ključne reči: genetička čistoća, markeri, kukuruz

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SEED GENETIC UNIFORMITY ASSESSMENT: FROM FIELD, THROUGH LABORATORY TO ARTIFICIAL INTELIGENCE

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"Genetic purity" refers to genuineness, originality, or degree of seeds sample contamination by undesired genetic varieties from same species. The success of hybrid seed production is dependent on parental inbred lines genetic purity. Genetic originality, uniformity and stability are assessed using morphological, biochemical and molecular markers. The approach based on morphological markers Grow-out-Test (GOT), is conventionally used in genetic purity assessment. A set of characteristics (descriptors) represents official measure for controlling genetic purity of seed lots and seed certification of maize hybrids, in many countries. However, replicated field observations are time-consuming, dependent on environment and skills of manpower recording data. Biochemical markers, seed storage proteins/isozymes, environmentally independent, enable quick and precise analysis of maize varieties uniformity. Still, biochemical assays cannot always effectively distinguish closely related inbred lines or hybrids. Molecular markers, based on DNA sequence variation (SSR) or single nucleotide polymorphism (SNP), aside for higher efficacy and reliability, provide an unbiased tool for analyzing genetic purity and identity of specific inbred lines or hybrids. However, application of these markers requires high initial input into equipment, methods optimization and education of expert analysts. Currently, investigations for artificial intelligence application in genuineness and uniformity of maize inbred lines and hybrids are in the fast lane. Based on processing of seed morphology images with hyperspectral reflection data on seed chemical composition, accurate and non-destructive methods for identification of genetically and phenotypically related genotypes are being developed. The presentation will give detailed insight into application of the methods for maize seeds genetic purity assessment.

Key words: genetic purity, markers, maize

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V-PP-03

RAZLIKE U NACIONALNIM I MEĐUNARODNIM PRAVILIMA ZA ISPITIVANJE SEMENA

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Razlike u pravilima za ispitivanje kvaliteta semena u domaćem prometu (Pravilnik o kvalitetu semena poljoprivrednog bilja Sl. SFRJ 47/1987) i izvozu (Međunarodna pravila za ispitivanje semena-ISTA pravila) razlog su prisustva nepodudarnostiu radu prilikom ispitivanja semena i tumačenja dobijenih rezultata. Kod pojedinih biljnih vrsta se koriste i drugačije metode ispitivanja, što dodatno može dovesti do različitih rezultata o kvalitetu jedne iste partije semena. Stoga je cilj ovog rada da se istaknu razlike koje postoje i ukaže na potrebu ujednačavanja nacionalnih i međunarodnih pravila za ispitivanje semena. Kroz ovaj pregledni rad prikazane su glavnerazlike prilikom uzorkovanja i najčešćih metoda ispitivanja kvaliteta semena: čistoće, klijavosti, mase 1000 semena i sadržaja vlage. Takođe su prikazane i razlike u kontroli kvaliteta uslova ispitivanja na koje laboratorije koje imaju i nacionalnu i međunarodnu akreditaciju moraju da obrate pažnju. U međunarodna ISTA pravila za ispitivanje semena unose se promene svake godine, na inicijativu laboratorija članica, na osnovu novih istraživanja i iskustava iz laboratorija širom sveta. Harmonizacija nacionalnih i međunarodnih pravila za ispitivanje semena umnogome bi olakšala rad u laboratorijama i doprinela ujednačenijim kriterijumima za ispitivanje semena i iznošenje rezultata ispitivanja.

Ključne reči: pravila, ispitivanje semena, ISTA.

Zahvalnica: Ovo istraživanje finansirano je od strane Ministarstva nauke, tehnološkog razvoja i inovacija Republike Srbije (broj ugovora: 451-03-47/2023-01/200040).

DIFFERENCES IN NATIONAL AND INTERNATIONAL SEED TESTING RULES

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Differences in the seed testing rules for domestic trade (Regulation on the quality of seeds of agricultural plants Sl. SFRJ 47/1987) and export (International rules for seed testing - ISTA rules) are reason for the lack of consistency in the seed testing and the interpretation of the obtained results. For certain species there are even different test methods, which can additionally lead to inconsistent test results of the same seed lot. Therefore, the objective of this paper is to highlight the differences that exist and point out the need to harmonize national and international rules for seed testing.Through this review, the main differences during sampling and the most common methods of seed testing are shown: purity, germination, 1000 seed weight and moisture content. Differences in the quality control of test conditions are also shown, which laboratories that have both national and international accreditation must pay attention to. International rules (ISTA) are changedevery year, at the initiative of member laboratories, based on new research and experiences from laboratories around the world. Harmonization of national and international rules for seed testing would greatly facilitate work in laboratories and contribute to uniform criteria for seed testing and reporting of test results.

Key words: rules, seed testing, ISTA

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V-PP-04

PRIMENA RAZLIČITIH MIKROBIOLOŠKIH SOJEVA U GAJENJU INDUSTRIJSKOG BILJA

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U prethodnom periodu sprovedena su istraživanja sa fokusom na primenu različitih vrsta mikrobioloških preparata u cilju njihovog mogućeg uticaja na morfološke, produktivne i kvalitativne osobine gajenog industrijskog bilja. Istraživanja su sprovedena u periodu od 2015. do 2023. godine kako na otvorenom polju tako i u laboratorijskim uslovima. U grupi industrijskog bilja ispitivane su uljane, proteinske, lekovite, aromatične i začinske biljke. Rezultati istraživanja su publikovani kako u međunarodnim tako i u nacionalnim časopisima, na međunarodnim konferencijama i kao tehnička rešenja na nacionalnom nivou. Korišćene su odabrane mešane mikrobiološke kulture koje pripadaju rodu *Streptomyces* sp., *Paenybacillus* sp., *Bacillus* sp., i *Hymenobacter* sp. a koje su izolovane iz zemljišta i šumskih sedimenata. U radu su korišćeni sojevi: CKS1 – *Paenybacillus chitinolyticus*, CKS3 – *Hymenobacter* sp., CKS7 – *Streptomyces fulvissimus* za gajenje uljanog lana i crnog kima, a za tretman semena organske soje korišćena je mešavina sojeva *Bacillus subtilis*, *Bradrhizobium japonicum* i *Azotobacter chroococum*. Primena mikrobioloških sojeva pri gajenju značajno utiče na povećanje sadržaja proteina i biljnih ulja u soji, esencijalnih masnih kiselina u uljanom lanu i ulju semena crnog kima, naročito omega-3, kao i povećanje sadržaja ukupnih polifenola, flavonoida i karotenoida i antioksidativne aktivnosti u ekstraktu uljanih vrsta. Mikrobiološki preparati imaju potencijal da doprinesu razvoju održivih poljoprivrednih sistema. Upotreba odabranih mikrobioloških kultura za tretman tokom inokulacije zemljišta i semena pri gajenju industrijskog bilja, ogleda se u poboljšanju nutritivnih i funkcionalnih svojstava biljaka koje su odličan izvor vrednih sastojaka hrane.

Ključne reči: Mikrobiološki sojevi, tretman i klijavost semena, uljani lan, crni kim, soja.

Zahvalnica: Ovaj rad je podržan od strane Fonda za inovacionu delatnost Ugovor o dodeli i korišćenju inovacionog vaučera broj 1338 i Ministarstva nauke, tehnološkog razvoja i inovacija Republike Srbije, Ugovor br. 451-03-47/2023-01/200003, 200011 i 200135.

APPLICATION OF DIFFERENT MICROBIOLOGICAL STRAINS IN THE CULTIVATION OF INDUSTRIAL PLANTS

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In the previous period, research was conducted with a focus on the application of various types of microbiological preparations with the aim of their possible influence on the morphological, productive and qualitative properties of cultivated industrial plants. Research was conducted in the period from 2015 to 2023. years both in the open field and in laboratory conditions. In the group of industrial plants, oil, protein, medicinal, aromatic and spice plants were investigated. Research results have been published in international and national journals, also at international conferences and as technical solutions at the national level. Selected mixed microbiological cultures belonging to the genus *Streptomyces* sp., *Paenybacillus* sp., *Bacillus* sp., and *Hymenobacter* sp. were used. and which were isolated from soil and forest sediments. The following strains were used in the work: CKS1 - *Paenybacillus chitinolyticus*, CKS3 - *Hymenobacter* sp., CKS7 - *Streptomyces fulvissimus* for the cultivation of linseed and black cumin, and a mixture of strains of *Bacillus subtilis*, *Bradrhizobium japonicum* and *Azotobacter chroococum* was used for the treatment of organic soybean seeds. The application of microbiological strains during cultivation has a significant effect on increasing the content of proteins and vegetable oils in soybeans, essential fatty acids in linseed oil and black cumin seed oil, especially omega-3, as well as increasing the content of total polyphenols, flavonoids and carotenoids and antioxidant activity in oilseed species extract. Microbiological preparations have the potential to contribute to the development of sustainable agricultural systems. The use of selected microbiological cultures for treatment during soil and seed inoculation during the cultivation of industrial plants is reflected in the improvement of the nutritional and functional properties of plants, which are an excellent source of valuable food ingredients.

Key words: Microbiological strains, treatment and germination of seeds, linseed oil, black cumin, soybeans.

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V-PP-05

SEMENARSTVO VIŠEGODIŠNJIH TRAVA – TRENDOVI U OPLEMENJIVANJU

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Višegodišnje trave predstavljaju kompleksnu i raznovrsnu grupu monokotiledonih biljaka koje žive širom planete, u različitim agroekološkim uslovima. Njihov agronomski značaj je posebno izražen usled činjenice da mogu uspevati na većim nadmorskim visinama gde se druge kulture ne mogu uspešno gajiti. One čine osnovnu hranu preživara u oblastima umerenog klimata kao komponente prirodnih i sejanih travnjaka i mogu se koristiti putem ispaše ili kosidbe u obliku sena, senaže ili silaže. Oplemenjivanje višegodošnjih trava se u Srbiji obavlja od polovine 20. veka, a Institut za krmno bilje Kruševac je jedina naučna institucija u kojoj se vrši oplemenjivanje ove grupe biljaka u Srbiji. Oplemenjivanje i selekcija višegodišnjih trava su dugotrajni procesi čiji uspeh zavisi od genetičke varijabilnosti početnog oplemenjivačkog materijala, čije utvrđivanje predstavlja prvi i osnovni korak u selekciji. Najčešće primenjivane metode oplemenjivanja višegodišnjih trava su masovna i fenotipska rekurentna selekcija, potpomognute progenim testiranjem, proverom kombinacionih sposobnosti i polikrosom. Najbitniji kriterijum oplemenjivanja, pored prinosa i kvaliteta suve materije, jeste produkcija semena. Prinos semena je izuzetno bitna osobina, jer nakon dugotrajne i složene selekcije koja za rezultat ima priznavanje nove sorte, predstoji dug put do široke primene te sorte u proizvodnji. Sorta se mora odlikovati dobrim prinosom semena. Oplemenjivanje ove osobine se vrši *per se*, ili preko brojnih komponenti prinosa semena kao što su broj generativnih izdanaka, dužina klasa odnosno metlice, broj klasića odnosno bočnih grana u metlici, masa hiljadu zrna, kvalitet semena. Površine na kojima se odvija proizvodnja semena višegodišnjih krmnih trava u Srbiji su u stalnom opadanju i odavno ne zadovoljavaju potrebe domaćeg tržišta pa se najveći procenat potrebnih količina semena uvozi.

Ključne reči: višegodišnje trave, oplemenjivanje, semenarstvo

Zahvalnica: Istraživanja su finansirana od strane Ministarstva nauke, tehnološkog razvoja i inovacija Republike Srbije (451-03-47/2023-01/200217).

BREEDING TRENDS IN PERENNIAL GRASSES SEED PRODUCTION

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Perennial grasses represent a complex and diverse group of monocotyledonous plants that live all over the planet, in different agroecological conditions. Their agronomic importance is especially pronounced due to the fact that they can be grown at higher altitudes where other crops cannot be successfully grown.As components of natural and sown grasslands, they are used as pasture, cutting, haylage and silage.Breeding of perennial grasses has been carried out in Serbia since the middle of the 20th century, and the Institute for Forage Crops Kruševac is the only scientific institution where the breeding of this group of plants is carried out in Serbia. Perennial grasses breeding are long-term processes whose success depends on the genetic variability of the initial breeding material, the determination of which represents the first and basic step in selection. The most dominant breeding methods are mass and phenotypic recurrent selection followed by progeny, diallel, and polycross tests. The most important breeding criterion, in addition to dry matter yield and quality, is seed production. Seed yield is a very important trait and the new cultivar must be characterized by good seed yield performance. Breeding of this trait is done per se, or through numerous seed yield components, such as the number of generative tillers, the length of the spike, i.e. panicles, the number of spikelets i.e. panicles side branches, one thousand seed weight, and seed quality. The areas for seed production of perennial forage grasses in Serbia are constantly decreasing and have not covered the needs of the domestic market for a long time, so the largest percentage of the required amount of seeds is imported.

Key words: perennial grasses, breeding, seed production

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V-USM-06

LABORATORIJSKA KLIJAVOST 101 LINIJE POLUSRODNIKA PANČIĆEVE OMORIKE

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Gotovo 150 godina od prvog opisa Pančićeve omorike (*Picea omorika*Pančić/ Purkyně), ne prestaje interes naučne i stručne zajednice za ovom vrstom. Tercijarni endem sa arealom u srednjem toku rijeke Drine se nalazi na IUCN listi ugroženih vrsta. Značajan broj istraživanja ukazuje na stalno prisutnu tendenciju opadanja broja populacija i stabala ove vrste kao i potrebu intenzivnijih aktivnosti u cilju njenog očuvanja. Tokom 2022/23. godine (jesen/proljeće) sakupljeno je sjeme sa 101 stabla ove vrste. Stabla su raspoređena u sedam prirodnih populacija (Tisovljak, Panjak, Tesla, Veliki Stolac, Grad, Šarena bukva i Radomišlja) i jednoj urbanoj populaciji (Banja Luka) u Republici Srpskoj (BiH). Odmah poslije dorade sjeme je skladišteno u hladnjačama, a zatim testirana klijavost standardnim ISTA metodama u dva vremenska perioda 27.03-10.04.2023. i 18.04.-02.05.2023. godine. Rezultati klijavosti ukazuju na veoma malu klijavost sjemena koja se uprosjeku na nivou linija polusrodnika kretala od 7 do 88% - prosjek za sve testirane linije 53%, dok jeučešće praznih sjemenki bilo od 1-76% ili prosječno 29%. Konstatovane su takođe značajne razlike u klijavosti na populacionom nivou od 23,7% za Panjak do 73,9% za Veliki Stolac. Učešće praznik sjemenki je bilo najveće kod lokaliteta Panjak (60,0%) i najmanje kod Velikog Stoca (11,3%). Rezultati ukazuju da populacije sa malim brojem stabala imaju manju klijavost. Ovako nizak procenat klijavost u prirodnim populacijama omorike ukazuje na potrebu hitnih aktivnosti na zaštiti ove vrste i pomoći njenoj prirodnoj obnovi (*in situ*), kao i osnivanju zasada izvan prirodnog areala (*ex situ* konzervaciji).

Ključne riječi:linije polusrodnika, klijavost, Pančićeva omorika

Zahvalnica: Autori zahvaljuju Ministarstvu poljoprivrede šumarstva i vodoprivrede u Vladi Republike Srpske za finansijsku podršku, Javnom preduzeću „Šume Republike Srpske“ za logističku podršku na terenu i predstavnicima preduzeća „Arborist Banja Luka“ na saradnji i uspješnoj realizaciji sakupljanja šišarica Pačićeve omorike.

LABORATORY GERMINATION OF 101 HALF-SIB LINES OF SERBIAN SPRUCE

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Almost 150 years since the first description of Serbian's spruce (*Picea omorika* Pančić/Purkyně), the scientific and professional community's interest in this species has not stopped. Tertiary endemic with an area in the middle course of the Drina river is on the IUCN list of endangered species. A significant number of research points to the ever-present tendency to decline in the number of populations and trees of this species, as well as the need for more intensive activities in order to preserve it.

During 2022/23. (autumn/spring) seeds were collected from 101 mother trees of this species. The trees are distributed in seven natural populations (Tisovljak, Panjak, Tesla, Veliki Stolac, Grad, Šarena bukva and Radomišlja) and one urban population (Banja Luka) in the Republic of Srpska (B&H). Immediately after processing, the seeds were stored in cold storage and then tested for germination using standard ISTA methods in two time periods: March 27 to April 10, 2023, and April 18 to May 02, 2023. Germination results indicate very low seed germination, which on average at the level of half-sib lines ranged from 7% to 88% - the average for all tested lines was 53%, while the share of empty seeds ranged from 1% to 76% or an average of 29%. Significant differences in germination at the population level were also found, from 23.7% for Panjak to 73.9% for Veliki Stolac. The share of empty seeds was the highest in the locality of Panjak (60.0%) and the lowest in Veliki Stolac (11.3%). The results indicate that populations with a smaller number of trees have lower germination. Such a low percentage of germination in natural populations indicates the need for urgent activities to protect this species and help its natural restoration (*in situ*), as well as the establishment of plantations outside the natural range (*ex situ* conservation).

Key words: half-sib lines, germination, Serbian spruce

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V-USM-07

REGULATIVA I TRENDOVI U OBLASTI SEMENARSTVA: ANALIZA PROIZVODNJE I DORADE SEMENA POLJOPRIVREDNIH BILJAKA U REPUBLICI SRBIJI ZA 2022. GODINU

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Oblast semenarstva obuhvata širok spektar zakona i propisa koji regulišu sve aspekte proizvodnje, dorade, kvaliteta i prometa (uključujući uvoz i izvoz) semena poljoprivrednog bilja. Ključni regulativni okviri u ovoj oblasti obuhvataju Zakon o semenu („Službeni glasnik RS“, br. 45/05 i 30/10), te niz pravilnika donetih u skladu sa tim zakonom. Među ovim pravilnicima je i Pravilnik o kvalitetu semena iz 1987. godine, donet na osnovu Zakona o standardizaciji, kao i različiti propisi koji se odnose na zaštitu i zdravlje biljaka. Važno je napomenuti da su postojeći pravni okviri delimično usklađeni sa Marketing Direktivama EU. Prema informacijama Ministarstva poljoprivrede, šumarstva i vodoprivrede za 2022. godinu, ukupno je požnjeveno seme poljoprivrednih biljaka sa površine od 34.367 hektara. Takođe, procenjuje se da je dorađeno ukupno 125.383 tona semena. Najveći udeo u požnjevenom semenu čine pšenica, sa 12.020 hektara i procenjenih 71.971 tona dorađeno semena, kao i kukuruz sa površine od 10.516 hektara, gde je dorađeno preko 16.850 tona semena. Seme soje je požnjeveno sa 5.377 hektara, a dorađeno je 11.150 tona. Kada se govori o krmnom bilju, lucerka je imala najveću požnjevenu površinu sa 1.244 hektara i procenjenih 1.071 tona dorađenog semena. U poređenju sa 2021. godinom, požnjevene površine semena tokom 2022. godine su povećane za 5,1%, dok je procena dorađenog semena smanjena za 26,4%. Što se tiče strnih žita, površine pod požnjevenim usevima tokom 2022. su smanjene za 15,4%, a procena dorađenog semena je smanjena za 30,9%. U pogledu semenske soje, zasejane površine su se smanjile za 0,2%, a proizvodnja semena soje je opala za 28%.

Ključne reči: zakonska regulativa, požnjeveno seme, dorađeno seme

REGULATION AND TRENDS IN THE FIELD OF SEED SCIENCE: ANALYSIS OF PRODUCTION AND PROCESSING OF CROP SEEDS IN THE REPUBLIC OF SERBIA FOR THE YEAR 2022

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The field of seed science encompasses a wide range of legislation that governs all aspects of production, processing, quality and trade (including import and export) of agricultural crop seeds. Key regulatory frameworks in this field include the Seed Law ("Official Gazette of RS", No. 45/05 and 30/10), as well as a series of regulations issued in accordance with this law. Among these regulations is the Seed Quality Regulation from 1987, enacted based on the Law on Standardization, along with various provisions related to plant protection and health. It is important to note that the existing legal frameworks are partially aligned with the Marketing Directives of the European Union. According to information from the Ministry of Agriculture, Forestry, and Water Management for the year 2022, a total of agricultural crop seeds were harvested from an area of 34,367 hectares. Additionally, an estimated 125,383 tons of seeds were processed. The majority of harvested seeds consisted of wheat, from an area of 12,020 hectares, with an estimated 71,971 tons of processed seed, as well as corn from an area of 10,516 hectares, where over 16,850 tons of seed were processed. Soybean seeds were harvested from 5,377 hectares and processed to yield 11,150 tons. In terms of forage crops, alfalfa had the largest harvested area of 1,244 hectares, with an estimated 1,071 tons of processed seed. Compared to the year 2021, harvested seed areas in 2022 increased by 5.1%, while the estimated processed seed decreased by 26.4%. When it comes to small grains, harvested areas for 2022 decreased by 15.4% compared to 2021, and the estimated processed seed also decreased by 30.9%. In the case of soybean seeds, sown areas decreased by 0.2%, and soybean seed production decreased by 28%.

Key words: legislation, harvested seed, processed seed

V-USM-08

DATUM SETVE KAO STRATEGIJA TOKOM PROIZVODNJE SEMENSKOG SUNCOKRETA U USLOVIMA PROMENJENE KLIME

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Klimatske promene značajno utiču na gajene kulture, smanjujući stabilnost prinosa i kvalitet semena. Adaptabilnost suncokreta na promenu klime ima ključnu ulogu u perspektivi gajenja ove kulture u Evropi. Prilagođavenjem besplatne agrotehničke mere kao što je datum setve suncokreta, poljoprivrednici mogu povećati prinose. Cilj istraživanja je da analizira i proceni kako različiti genotipovi reaguju na različite datume setve u uslovima promenjene klime, te da identifikuje najpovoljnije uslove za maksimalne prinose semena, ulja, kvalitet proizvedenog semena i morfološke osobine. Istraživanje je sprovedeno od 2020. do 2022. godine na oglednim poljima Instituta za ratarstvo i povrtarstvo Novi Sad. Ogled se sastojao od tri izolacije u četiri ponavljanja sa šest genotipova, kao simulacija semenske proizvodnje osnovne kategorije semena i setrifikovane kategorije semena I generacije. Svi genotipovi su posejani u četiri različita datuma setve sa razmakom od dve nedelje između datuma. Analizom rezultata može se primetiti da datum setve, genotip i njihova interakcija značajno utiču na variranje ispitivanih osobina. Utvrđeno je da povećanje prinosa semena prati povećanje kvaliteta proizvedenog semena u svim datumima setve. Korelacijama je utvrđeno da, smanjenje padavina u fazi nalivanja semena utiče na smanjenje prinosa semena i ulja. Primećeno je da visoke temperature od nicanja do butonizacije imaju negativan uticaj na prinos semena, ali povećavaju visinu biljke, energiju klijanja i klijavost proizvedenog semena. Visoke temperature tokom cvetanja negativno utiču na energiju klijanja i klijavost proizvedenog semena, ali pozitivno na prečnik glave. Prilagođavanje datuma setve može biti pouzdan alat za odgovor na buduće klimatske promene. Pomeranje optimalnih datuma setve (sredina aprila) na kasniji period (početak ili sredina maja) može smanjiti stresne uslove tokom oplodnje i nalivanja semena, rezultirajući većim prinosima i boljim kvalitetom proizvedenog semena, što je cilj svake semenske proizvodnje.

Ključne reči: datum setve, promena klime, semenska proizvodnja suncokreta

Zahvalnica: Rad je podržalo Ministarstvo nauke, tehnološkog razvoja i inovacija Republike Srbije, ugovor broj 451-03-47/2023-01/200032, Fond za nauku Republike Srbije, program IDEJE - "SmartSun", br. 7732457, Evropska komisija kroz projekat Twining zapadnog Balkana "CROPINNO", br. 101059784, Centar izuzetnih vrednosti za inovacije u oplemenjivanju biljaka tolerantnih na promene klime - Climate Crops, Institut za ratarstvo i povrtarstvo, Novi Sad, Srbija.

SOWING DATE AS A STRATEGY DURING SEED SUNFLOWER PRODUCTION IN CONDITIONS OF A CHANGED CLIMATE

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Climate change has a significant impact on cultivated crops, reducing yield stability and seed quality. The adaptability of sunflower to climate change plays a key role in the perspective of growing this crop in Europe. By adjusting a free agrotechnical measure such as the sunflower sowing date, farmers can increase yields. The goal of the research is to analyze and evaluate how different genotypes react to different sowing dates in conditions of a changed climate, and to identify the most favorable conditions for maximum yields of seeds, oil, quality of produced seeds and morphological characteristics. The research was conducted from 2020 to 2022 on the experimental fields of Institute of Field and Vegetable Crops in Novi Sad. The experiment consisted of three isolations in four replications with six genotypes, as a simulation of seed production of the basic seed category and the certified seed category of the first generation. All genotypes were sown on four different sowing dates with a two-week interval between dates. Analyzing the results, it can be observed that the date of sowing, the genotype and their interaction significantly affect the variation of the tested traits. It was found that the increase in seed yield is accompanied by an increase in the quality of the produced seed on all sowing dates. Through correlations, it was determined that the decrease in precipitation during the seed-filling phase affects the decrease in seed and oil yields. It was observed that high temperatures from germination to budding have a negative effect on seed yield, but increase plant height, germination energy and germination of the seeds produced. High temperatures during flowering have a negative effect on the energy of germination and germination of the seeds produced, but a positive effect on the diameter of the head. Adjusting sowing dates can be a reliable tool to respond to future climate change. Shifting the optimal sowing dates (mid-April) to a later period (early or mid-May) can reduce stressful conditions during pollination and the seed filling, resulting in higher yields and better quality seed production, which is the goal of any seed production.

Key words: sowing date, climate change, sunflower seed production

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V-POS-09

REZULTATI KLIJAVOSTI I MASE 1000 ZRNA RAZLIČITIH BILJNIH VRSTA MIKROPOVRĆA

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Cilj istraživanja je bio utvrditi klijavost semena i masu 1000 zrna kod različitih biljnih vrsta mikropovrća: kukuruza kokičara (*Zea mays L.ssp. everta Sturt*), crvenog kupusa (*Brassica oleracea L. convar.capitata convar rubra*), luka vlašca (*Allium schoenoprasum*)-sorta Welta, cvekle (*Beta vulgaris*)-sorta Detroit, japanske i kineske rotkve (*Raphanus sativus*). Semena ovih biljnih vrsta mikropovrća bila su proizvedena 2022. godine. Klijavost semena je važan parametar kvaliteta semena, koji posebno dolazi do izražaja kada su nepovoljni i otežavajući uslovi spoljašnje sredine za klijanje i nicanje semena. Energija klijanja predstavlja brzinu i ravnomernost klijanja izraženu u procentima klijalih semena. Veoma važan pokazatelj kvaliteta semena je masa 1000 semena. Istraživanja su rađena prema domaćem Pravilniku o kvalitetu semena poljoprivrednog bilja, korišćena je standardna metoda između dvostrukog filter papira. Dobijeni rezultati energije klijanja i ukupne klijavosti su pokazali da najveće vrednosti navedenih parametara ima kineska rotkva u odnosu na sve ostale vrste mikropovrća. Najnižu vrednost energije klijanja je imala cvekla (51%), a najvišu kineska rotkva (97%). Najmanju ukupnu klijavost je u proseku imao luk vlašac (81%), a najveću ukupnu klijavost je imala kineska rotkva (97%). Najveću masu 1000 zrna je imao kukuruz kokičar (161,23 g), a najnižu crveni kupus (3,27 g). Najnižu vrednost energije klijanja je imala cvekla jer u omotaču semena postoji visok sadržaj inhibitora klijanja u odnosu na ostale biljne vrste. Minimalna klijavoost potrebna radi stavljanja semena cvekle u promet je 65%. Seme rotkve pokazuje najveću klijavost zbog niskog sadržaja inhibitora klijanja i oblika semena.

Ključne reči: mikropovrće, klijavost semena.

Zahvalnica: Ovo istraživanje je podržalo Ministarstvo za nauku, tehnološki razvoj i inovacije Republike Srbije, grant broj: 451-03-47/2023-01/200054.

RESULTS OF GERMINATION AND 1000 SEED WEIGHT OF DIFFERENT PLANT TYPES OF MICRO VEGETABLES

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The aim of the research was to determine seed germination and the weight of 1000 grains in different types of microvegetables: popcorn (*Zea mays L.ssp. everta Sturt*), red cabbage *(Brassica oleracea L. convar.capitata convar rubra*), chives (*Allium schoenoprasum*) - Welta variety, beetroots (*Beta vulgaris*) - Detroit variety, Japanese and Chinese radishes (*Raphanus sativus*). The seeds of these types of micro-vegetables were produced in 2022. Seed germination is an important parameter of seed quality, which especially comes to the fore when the external conditions for seed germination and sprout are unfavorable and difficult. Germination energy represents the rate and uniformity of germination expressed as a percentage of germinated seeds. A very important indicator of seed quality is the mass of 1000 seeds. Research was done according to the domestic Rulebook on the quality of seeds of agricultural plants, the standard method between double filter paper was used. The obtained results of germination energy and total germination showed that Chinese radish has the highest values of the mentioned parameters compared to all other types of micro-vegetables. Beetroot had the lowest germination energy value (51%), and Chinese radish had the highest (97%). On average, chives had the lowest overall germination (81%), and Chinese radish had the highest overall germination (97%). Pop corn had the highest weight per 1000 grains (161.23 g), and red cabbage had the lowest (3.27 g). Beetroot had the lowest germination energy value because the seed coat has a high content of germination inhibitors compared to other plant species. The minimum germination required to put beet seeds on the market is 65%. Radish seeds show the highest germination due to the low content of germination inhibitors and the shape of the seeds.

Key words: microvegetables, seed germination.

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V-POS-10

UTICAJ ČAJA RASTAVIĆA (*Equisetum arvense* L.) NA KLIJAVOST SEMENA BELOG SLEZA (*Althaea officinalis* L.), NEVENA (*Calendula officinalis* L.) I PERŠUNA LIŠĆARA (*Petroselinum sativum* Hoffm.)

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Upotreba pripravaka na bazi lekovitog bilja za ishranu i zaštitu bilja iz godine u godinu dobija sve više na značaju. Jedna od takvih je rastavić/preslica (*Equisetum arvense* L.) koji zbog silicijumove kiseline u velikom procentu suzbija pepelnicu, pegavost, sivu plesan, rđu, moniliju itd. U radu je prikazan uticaj čaja rastavića na klijavost semena belog sleza (*Althaea officinalis* L.), nevena (*Calendula officinalis* L.) i peršuna lišćara (*Petroselinum sativum* Hoffm.). Istraživanja su sprovedena u laboratoriji za semenarstvo Instituta za proučavanje lekovitog bilja „Dr Josif Pančić" u Pančevu, tokom 2020. godine. Laboratorijska ispitivanja semena obuhvatila su ispitivanje morfološko fizioloških osobina (Energija klijanja – EK, Ukupna klijavost – UK). Pre nego je seme stavljeno na klijanje, u Petrijevim posudama na filter papiru na temperaturnom režimu od 20°C – konstantno, seme je tretirano čajem rastavića (jedan deo se razredi sa 5 delova vode), druga varijanta je predstavljala kontrolnu varijantu gde je dodata destilovana voda. Laboratorijska ispitivanja semena obavljena su u skladu sa Pravilnikom o kvalitetu semena poljoprivrednog bilja, prilikom čega su zabeleženi sledeći rezultati: primena čaja od rastavića kod semena belog sleza uticala je na prosečno 59% klijalih semena, dok je kod kontrolne varijante klijavost bila daleko manja i iznosila 26%. Klijavost semena nevena je takođe imala značajno povećanje kada je tretman čaja rastavića u pitanju. Tretirana semena nevena čajem od rastavića imala su prosečnu klijavost od 73%, dok je u kontrolnoj varijanti klijavost iznosila 52%. Kod semena peršuna lišćara, vrednost treriranog semena čajem od rastavića bila je 84% koja nije bila statistički značajna u odnosu na vrednost klijavosti semena tretiranog destilovanom vodom (74%).

Ključne reči: čaj rastavića (*Equisetum arvense*), klijavost semena, beli slez (*Althaea officinalis*), neven (*Calendula officinalis*), peršun lišćar (*Petroselinum sativum*).

Zahvalnica: Ovaj rad je podržan od strane Ministarstva nauke, tehnološkog razvoja i inovacija Republike Srbije, Ugovor br. 451-03-47/2023-01/200003, 200011 i 200032.

THE INFLUENCE OF HORSETAIL TEA (*Equisetum arvense* L.) ON THE SEED GERMINATION OF MARSHMALLOW (*Althaea officinalis* L.), POT MARIGOLD (*Calendula officinalis* L.) AND PARSLEY (*Petroselinum sativum* Hoffm.)

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The use of preparations based on medicinal plants for the nutrition and protection of plants is gaining more and more importance every year. One of these is horsetail (*Equisetum arvense* L.), which, due to its silicic acid, suppresses powdery mildew, spotting, gray mold, rust, monilia, etc. in a large percentage. The paper shows the influence of horsetail tea on the germination of the seeds of marshmallow (*Althaea officinalis* L.), pot marigold (*Calendula officinalis* L.) and parsley (*Petroselinum sativum* Hoffm.). The research was conducted in the laboratory for seed production of the Institute for Medicinal Plants Research „Dr Josif Pančić" in Pančevo, during 2020. Laboratory testing of seeds included examination of morphological and physiological properties (Germination energy - EK, Total germination - UK). Before the seeds were placed for germination, in Petri dishes on filter paper at a temperature regime of 20°C - constant, the seeds were treated with horsetail tea (one part is mixed with 5 parts of water), the other variant represented the control variant where distilled water. Laboratory tests of seeds were carried out in accordance with the Rulebook on the quality of seeds of agricultural plants, during which the following results were recorded: the application of horsetail tea to marshmallow seeds affected an average of 59% of the germinated seeds, while the germination rate of the control variant was much lower and amounted to 26%. Pot marigold seed germination also had a significant increase in horsetail tea treatment. The pot marigold seeds treated with horsetail tea had an average germination rate of 73%, while in the control variety the germination rate was 52%. In the case of parsley seeds, the value of seeds which treated with horsetail tea was 84%, it was not statistically significant compared to the value of germination of seeds treated with distilled water (74%).

Key words: horsetail tea (*Equisetum arvense*), seed germination, marshmallow (*Althaea officinalis*), pot marigold (*Calendula officinalis*), parsley (*Petroselinum sativum*).

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V-POS-11

GIBERELINSKA KISELINA KAO PREDSETVENI TRETMAN SEMENA *TAXUS BACCATA*

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Taxus baccata (L.) je retka i zaštićena vrsta u šumama Srbije. Obnavljanje *Taxus baccata* u šumama je prepušteno prirodi i ne postoje podaci o proizvodnji šumskih sadnica ove vrste u našim šumskim rasadnicima. Razmnožavanje *Taxus baccata* za potrebe proizvodnje ukrasnog sadnog materijala se uglavnom sprovodi vegetativnim putem (reznicama), a generativno razmnožavanje ove vrste je zanemareno usled izrazito dormantnog semena. Problem dormantnosti semena *Taxus baccata* je dobro dokumentovan u literaturi, a preporučeni metodi za otklanjanje dormantnosti su dugotrajni i zasnivaju se na primeni tople i hladne, suve ili vlažne stratifikacije u različitim trajanjima. Pored dužine trajanja stratifikacije, problem predstavlja i relativno mala klijavost nakon primene neke od ovih metoda. Sa ciljem da se dormantnost otkloni i izazove klijanje u što većem procentu u ovom radu je testiran uticaj giberelinske kiseline (GA4/GA7) na klijanje semena *Taxus baccata*. Seme koje je sakupljeno sa 10 parkovskih stabala je podvrgnuto suvo-hladnoj stratifikaciji i hladno-vlažnoj stratifikaciji u trajanju od 16 nedelja. Uzorak od po 200 semena je potopljen 24 časa u rastvor giberelinske kiseline (100 ppm, 300 ppm i 500 ppm) i vodonik-peroksida, dok je isti broj semena iz obe vrste stratifikata posejan bez potapanja. Ogled je izvršen u dva ponavljanja za svaku vrstu stratifikata, a sproveden je u staklari Šumarskog fakulteta Univerziteta u Beogradu. Klijanje semena je zabeleženo u proleće naredne godine, i trajalo je 2 meseca (maj-jun 2023 godine). Najveća klijavost semena je zabeležena u tretmanu giberelinske kiseline u najvećoj testiranoj koncentraciji bez obzira na vrstu prethodne stratifikacije (suvo-hladna 22.5%; vlažno-hladna 22.75%, u poređenju sa kontrolisanim 10,5% za obe stratifikacije).

Ključne reči: *Taxus baccata*, seme, giberelinska kiselina, predsetveni tretman

GIBBERELLIC ACID AS PRE-SOWING TREATMENT FOR *TAXUS BACCATA* SEEDS

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Taxus baccata (L.) is a rare and protected species in the forests of Serbia. *Taxus baccata* regeneration in forests is left to nature and there is no data on the production of forest seedlings of this species in our forest nurseries. Reproduction of *Taxus baccata* for the purposes of production of decorative planting material is mainly carried out vegetatively (by cuttings), and generative reproduction of this species is neglected due to extremely dormant seeds. The problem of *Taxus baccata* seed dormancy is well documented in the literature, and the recommended methods for eliminating dormancy are long-term and based on the application of hot and cold and dry or wet stratification for different durations. In addition to the length of the stratification, the problem is also relatively low germination after applying one of these methods. With the aim of removing dormancy and causing germination in the highest possible percentage, this paper tested the influence of gibberellic acid (GA4/GA7) on the germination of *Taxus baccata* seeds. Seeds collected from 10 park trees were subjected to dry-cold stratification and cold-wet stratification for 16 weeks. A sample of 200 seeds each was immersed for 24 hours in a solution of gibberellic acid (100 ppm, 300 ppm and 500 ppm) and hydrogen peroxide, while the same number of seeds from both types of stratification was sown without immersion. The experiment was carried out in two repetitions for each type of stratification, and was conducted in the glasshouse of the Faculty of Forestry, University of Belgrade. Seed germination was recorded in the spring of the following year, and lasted for 2 months (May-June 2023). The highest seed germination was recorded in the gibberellic acid treatment at the highest tested concentration, regardless of the type of previous stratification (dry-cold 22.5%; wet-cold 22.75%).

Key words: *Taxus baccata*, seed, gibberellic acid, pre-sowing treatment

V-POS-12

UTICAJ GODINE I LOKALITETA NA KLIJAVOST SEMENA KOD INBRED LINIJA SUNCOKRETA

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Jedna od najvažnijih karakteristika semena je njegova klijavost i ona je kao svojstvo karakteristično za svaki pojedinačni genotip, za svaku biljnu vrstu. Na njega utiče velik broj različitih činilaca, počev od klimatskih činilaca, preko uticaja agrotehničkih mera i oštećenja nastalih tokom proizvodnje semena pa do uticaja načina sušenja, dorade, tretiranja i skladištenja dorađenog semena. Ispitivanje je vršeno, u poljskim uslovima, na parcelama gde je organizovana semenska proizvodnja roditeljskih komponenti hibrida suncokreta. Semenska proizvodnja organizovana je na tri različita lokaliteta. Posmatranje se odvijalo tokom tri godine. Ispitivanje je obavljeno na 18 različitih genotipova. Od ukupnog broja posmatranih genotipova, 10 genotipova predstavljale su linije na bazi CMS-a dok su preostalih 8 genotipova predstavljali restorer linije. Na osnovu dobijenih rezultata utvrđeno je da su restoreri imali veće vrednosti klijavosti u odnosu na sterilne linije. Razlike između godina istraživanja su značajne i kod sterilnih linija i kod linija restorera. Značajne razlike javljaju se takođe i između pojedinih linija u okviru jedne godine kao i između dobijenih rezultata za svaku liniju. Linije L-3, L-1 i R-6 ostvarile su najbolje rezultate klijavosti, u različitim godinama. Za razliku od navedenih linija najlošije rezultate ostvarile su linije L-2 i R-4.

Ključne reči: roditeljske linije suncokreta, klijavost semena

Zahvalnica: Istraživanja su podržana od Ministarstva nauke, tehnološkog razvoja i inovacija Republike Srbije i Instituta za ratarstvo i povrtarstvo na osnovu ugovora o realizaciji i finansiranju naučnoistraživačkog rada broj: 451-03-47/2023-01/200032

EFFECT OF YEAR AND LOCATION ON SEED GERMINATION IN SUNFLOWER INBRED LINES

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One of the most important characteristics of a seed is its germination, and as a property, it is characteristic for each genotype, and for each plant species. It is influenced by a large number of different factors, starting from climatic factors, through the influence of cultivation practices and damage caused during seed production, to the influence of the method of drying, processing, treatment and storage of processed seeds. The test was carried out, in field conditions, on plots where seed production of parental components of sunflower hybrids was organized. Seed production is organized in three different locations. The observation took place over three years. The test was performed on 18 different genotypes. From the total number of observed genotypes, 10 genotypes were CMS-based lines, while the remaining 8 genotypes were restorer lines. Based on the obtained results, it was determined that restorers had higher germination values compared to sterile lines. Differences between years of research are significant both in sterile lines and in restorer lines. Significant differences also occurred between individual lines within one year, as well as between the results obtained for each line. Lines L-3, L-1 and R-6 achieved the best germination results, in different years. In contrast to the mentioned lines, the worst results were achieved by lines L-2 and R-4.

Key words: sunflower parental lines, seed germination

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V-POS-13

ZNAČAJ PRIMENE TRETMANA SEMENA NA POVEĆANJE POKAZATELJA KVALITETA SEMENA PAPRIKE

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Cilj rada je bio da se utvrdi uticaj sorte i tretmana semena na glavne pokazatelje kvaliteta semena tri sorte paprika (Merak, Ordesa i PWC 15001). Ogled je izveden 2022. godine u Laboratoriji za kontrolu kvaliteta semena i sadnog materijala Instituta za zaštitu bilja i životnu sredinu u Beogradu. Kao materijal u ogledu korišćeno je seme sorti paprika proizvedeno u 2022. godini. Tretman semena je izveden sa 1% rastvorom natrijum hipohlorida u trajanju od 10 minuta, zatim je ispirano i osušeno. Ispitivanje klijavosti semena izvršeno je standardnom laboratorijskom metodom na filter papiru navlaženom 0,2% vodenim rastvorom KNO_3 na 4 x 100 semena. Seme je inkubirano 14 dana na temperaturi 20 - 30°C i relativnoj vlažnosti vazduha od 95%. Sedmog dana inkubacije ocenjena je energija klijanja, a 14 dana ukupna klijavost. Zdravstvena ispravnost semena ocenjivana je vizuelnom metodom. Dobijeni rezultati ukazuju da su pojedinačni faktori sorta i tretman semena značajno uticali ($p< 0,01$) na energiju klijanja, ukupnu klijavost i procenat bolesnog semena, dok njihov uticaj na procenat nenormalnog semena nije utvrđen. Takođe, uticaj interakcije faktora na posmatrane pokazatelje kvaliteta semena je izostao. Primenjeni tretman na semenu uticao je u proseku na povećanje energije klijanja i ukupne klijavosti za po 4% kod sve tri ispitivane sorte paprika. Kod sorti paprika utvrđeno je prisustvo samo patogena *Alternaria* sp., čija se zastupljenost kretala od 6 do 9% u varijantama bez tretmana semena (kontrola). Primenom ovog tretmana kod ispitivanih sorti procenat zaraženog semena *Alternaria* sp. se značajno smanjio ispod 5%, što predstavlja zakonski maksimum za stavljanje semena paprike u promet.

Ključne reči: paprika, klijavost, *Alternaria* sp.

Zahvalnica: Ministarstvu obrazovanja, nauke i tehnološkog razvoja Rep. Srbije, Ugovor br. 451-03-47/2023-01

THE IMPACT OF SEED TREATMENT APPLICATION ON INCREASE OF PEPPER SEED QUALITY INDICATORS

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The aim of the work was to determine the influence of variety and seed treatment on the main indicators of seed quality of three pepper varieties. The experiment was carried out in 2022 at the Laboratory for Quality Control of Seeds and Planting Material of the Institute for Plant Protection and the Environment in Belgrade. As material in the experiment, seeds of pepper varieties produced in 2022 were used. The seeds were treated with a 1% sodium hypochlorite solution for 10 minutes, then rinsed and dried. Seed germination was tested using a standard laboratory method on filter paper moistened with a 0.2% aqueous solution of KNO_3 on 4 x 100 seeds. The seeds were incubated for 14 days at a temperature of 20 - 30°C and a relative humidity of 95%. On the seventh day of incubation, the energy of germination was evaluated, and on the 14th, the total germination, that is, the number of typical seedlings. The healthiness of the seeds was assessed by the visual method. The obtained results indicate that the individual factors of variety and seed treatment significantly influenced ($p< 0.01$) the energy of germination, total germination and the percentage of diseased seeds, while their influence on the percentage of abnormal seeds was not determined. Also, the influence of the interaction of factors on the observed indicators of seed quality was absent. The treatment applied to the seeds affected on increase in the energy of germination and total germination by 4% in all three tested pepper varieties. In pepper varieties, the presence of only the pathogen *Alternaria* sp. was determined, whose prevalence ranged from 6 to 9% in varieties without seed treatment (control). By applying this treatment to the investigated varieties, the percentage of infected seeds of *Alternaria* sp. has significantly decreased below 5%, which is the legal maximum for placing pepper seeds on the market.

Key words: pepper, germination, Alternaria sp.

Acknowledgment: Ministry of Education, Science and Technological Development of the Republic of Serbia, Contract no. 451-03-47/2023-01

V-POS-14

PARAMETRI KVALITETA SEMENA ULJANE REPICE PRI RAZLIČITIM TRETMANIMA

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Proizvodnja uljane repice u Srbiji prati trend porasta površina pod uljaricama u svetu. Kao najvažniji preduslov za uspešnu proizvodnju i postizanje visokih prinosa neophodno je obezbediti seme visokog kvaliteta i osigurati optimalan sklop biljaka. Kvalitetan tretman semena se pokazao kao najbolje rešenje za zaštitu biljaka u početnim fazama razvoja. Ispitivanja su izvedena na tri sorte ozime uljane repice: Ana, Zorica i Jasna. Seme je tretirano fungicidima sa aktivnim materijama karboksin + tiram i fluopikolid + fluoksastrobin, kao i insekticidom sa a.m. flupiradifuron, a kontrola je bilo netretirano seme. Uticaj tretmana ispitan je primenom standardnog laboratorijskog metoda i nakon 7 dana utvrđeni su klijavost semena i dužina ponika. Klijavost semena u kontroli se kretala od 92% do 93%. U proseku, najveću klijavost imalo je seme tretirano sa fungicidom fluopikolid + fluoksastrobin (94 – 98%). Značajno nižu klijavost imalo je seme sorte Jasna (84%) i Ana (88%) tretirano kombinacijom fungicida karboksin + tiram i insekticida. Dužina ponika je bila statistički značajno najveća kod semena sorte Jasna (18,27 cm) tretiranog fungicidom fluopikolid + fluoksastrobin, koja je i u proseku za sve tretmane imala najveću vrednost ispitivanog parametra. Najniže vrednosti su dobijene kod ponika sorte Zorica (13,39 cm) pri tretmanu fungicidom karboksin + tiram. Za uspešnu proizvodnju treba odabirati tretmane koji imaju pozitivan efekat na kvalitet semena.

Ključne reči: uljana repica, seme, klijavost, dužina ponika

Zahvalnica: Rad je podržalo Ministarstvo nauke, tehnološkog razvoja i inovacija Republike Srbije (451-03-47/2023-01/200032), Evropska komisija kroz projekat Twinning Western Balkans CROPINNO (101059784) i Centar izuzetnih vrednosti za inovacije u oplemenjivanju biljaka tolerantnih na promene klime – Climate Crops Instituta za ratarstvo i povrtarstvo, Instituta od nacionalnog značaja za Republiku Srbiju, Novi Sad, Srbija.

OILSEED RAPE SEED QUALITY PARAMETERS IN RELATION TO TREATMENT

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The production of oilseed rape in Serbia follows the trend of increasing areas under oil crops in the world. As the most important precondition for successful production and achieving high yields, it is necessary to provide high-quality seeds and ensure an optimal plant number per hectare. Quality seed treatment has proven to be the best solution for plant protection in the initial stages of development. Test was performed on three varieties of winter rapeseed: Ana, Zorica and Jasna. The seeds were treated with fungicides with a.i. carboxin + thiram and fluopicolide + fluoxastrobin, as well as an insecticide with a.i. flupyradifurone, and control was untreated seeds. The effect of the treatment was tested using a standard laboratory method, and after 7 days, seed germination and seedling length were determined. Seed germination in the control ranged from 92% to 93%. On average, seeds treated with the fungicide fluopicolide + fluoxastrobin had the highest germination (94-98%). The seeds of Jasna (84%) and Ana (88%) varieties treated with the combination of fungicide carboxin + thiram and insecticide had a significantly lower germination rate. The seedlings length was statistically significantly highest in the seeds of Jasna variety (18.27 cm) treated with fungicide fluopicolide + fluoxastrobin, which had the highest value of the tested parameter on average for all treatments. The lowest values were obtained in seedlings of Zorica variety (13.39 cm) treated with the fungicide carboxin + thiram. For successful production, treatments that have a positive effect on seed quality should be selected.

Key words: rape seed, seed, germination, seedling length

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V-POS-15

UTICAJ LOKALITETA NA PARAMETERE KVALITETA SEMENA PAPRIKE (*CAPSICUM ANNUUM* L.)

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Paprika (*Capsicum annuum* L.) kao komercijalna vrsta gaji se širom sveta. Godišnja proizvodnja paprike dostigla je oko 3.9 miliona tona. Površine pod zasadima paprike u Srbiji procenjene su na 10.278 ha u 2021. godini, dok je ukupna proizvodnja iznosila 147.663 tone. U ovoj studiji vršeno je ispitivanje semena dva genotipa paprike dobijenih sa lokacija Kula i Smederevska Palanka. Ispitivanje je vršeno standardnim metodama za procenu klijavosti i zdravstvene ispravnosti semena. Kvalitet semena paprike procenjen je na osnovu parametara klijanja, vlage i zdravstvene ispravnosti semena za sezonu 2022 godine. Energija klijanja iznosila je 75% (Strižanka) i 85% (Župska rana) za lokalitet Smederevska Palanka, dok je za Kulu iznosila 65% (Strižanka) i 55% (Župska rana) ($p<0.05$). Ukupna klijavost iznosila je 88% (Strižanka) i 90% (Župska Rana) za lokalitet u Smederevska Palanka, dok je u Kuli iznosila 80% (Strižanka) i 70% (Župska Rana). Sadržaj vlage dostigao je 11.5% i 11% za Strižanku i Župsku ranu, respektivno ($p>0.05$) sa lokaliteta u Smederevskoj Palanci. U uzorcima dobijenih sa lokaliteta u Kuli sadržaj vlage je iznosio 12.5% za Strižanku i 9.5% za Župsku ranu ($p<0.05$). Zdravstvena ispravnost semena testirana je na *Alternaria* spp. i *Fusarium* spp. Procenat infekcije za Strižanku i Župsku Ranu iznosio je 1% (Smederevska Palanka) ($p>0.05$), dok je u Kuli iznosio 3% za Strižanku i 5% za Župsku Ranu ($p<0.05$). Dobijeni podaci za parametre kvaliteta ukazuju na značajnu razliku između lokaliteta Smederevska Palanka i Kula. Buduća istraživanja će biti vezana za analizu zemljista i ukupni prinos po parceli na lokacijama Smederevska Palanka i Kula.

Ključne reči: energija, klijavost, sadržaj vlage, zdravstvena ispravnost, lokacija

Zahvalnica: Ovaj rad je podržan od strane Ministarstva nauke, tehnološkog razvoja i inovacija Republike Srbije, Ugovor br.451-03-47/2023-01/200117,451-03-47/2023-01/200010,451-03-47/2023-01/ 200040.

INFLUENCE OF LOCATION ON QUALITY PARAMETERS OF PEPPER SEEDS (*CAPSICUM ANNUUM* L.)

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Pepper (*Capsicum annuum* L.) as a commercial species is cultivated worldwide. The annual production of pepper has reached approximately 3.9 million tons. The area under pepper plants in Serbia were assessed at 10.278 ha in 2021, and overall production at 147.663 tons. Seed testing of two genotypes of pepper from two localities (Kula and Smederevska Palanka) was performed using standard methods for assessing seed quality and health, based on germination parameters, moisture and seed health obtained during 2022 season. Germination energy was 75% and 85% for Strizanka and Zupska Rana, in Smederevska Palanka, respectively. In Kula, germination energy was statistically significantly lower and accounted for 65% and 55% for Strizanka and Zupska Rana ($p<0.05$). Total germination for Strizanka and Zupska rana was 88% and 90% in Smederevska Palanka, while at Kula location it was 80% and 70%. The moisture content was 11.5% and 11% for Strizanka and Zupska Rana, respectively ($p>0.05$) in Smederevska Palanka. The moisture content in Kula was 12.5% and 9.5% for Strizanka and Zupska Rana, respectively. Seed health was tested on phytopathogenic fungi *Alternaria* spp. and *Fusarium* spp. For Strizanka and Zupska Rana amounted to 1% (Smederevska Palanka) ($p>0.05$).While in Kula amounted to 3% and 5%, respectively ($p<0.05$) and they were statistically significant ($p<0.05$). The obtained data of seed quality parameters indicated a statistically significant difference between Smederevska Palanka and Kula locations. Future research will be related to soil analysis and total yield per plot at two locations.

Key words: energy, germination, seed health, moisture content, location

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V-POS-16

EFEKAT HEMIJSKOG TRETMANA NA SADRŽAJ VLAGE UPAKOVANOG SEMENA

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Površinska primena hemijskih tretmana semena u vidu vodenih rastvora je uobičajena praksa u doradi semena u cilju zaštite semena od patogena i štetočina tokom početnih faza klijanja. Međutim, primena vodenih rastvora na površini semena može izazvati povećanje sadržaja vlage unutar semena, što za posledicu ima povećan rizik od gubitka klijavosti usled ubrzanog starenja tokom skladištenja kao i obilnog razvoja patogena i saprofita. Prilikom rutinskog laboratorijskog ispitivanja sadržaja vlage, u nekim uzorcima su uočene vrednosti koje se graniče sa propisanim. Ovo je iniciralo istraživanje sa ciljem da se utvrdi da li vlaga, koja se nanosi na seme tokom tretmana, ostaje na površini i isparava u okolni prostor ili je seme apsorbuje. Uzorci semena strnih žita za ispitivanje sadržaja vlage uzeti su pre hemijskog tretmana, neposredno posle tretmana i nakon izvesnog perioda čuvanja upakovanog semena. Sadržaj vlage je određen gravimetrijskom metodom, propisanom od strane ISTA. Dobijeni rezultati ukazuju da hemijski tretman povećava sadržaj vlage u semenu koji ostaje uglavnom stabilan tokom čuvanja. Iako povećanje sadržaja vlage nije statistički značajno, činjenica da vlaga ostaje u semenu ukazuje da je potrebno uzeti u obzir sadrža vlage u semenu pre primene tretmana i da je potrebno razmotriti redukciju udela vode u formulaciji tretmana do nivoa koji ne bi kompromitovao distribuciju tretmana po površini semena.

Ključne reči: seme, vlaga, tretman, starenje semena

Zahvalnica: Ovo istraživanje finansirano je od strane Ministarstva nauke, tehnološkog razvoja i inovacija Republike Srbije (broj ugovora: 451-03-47/2023-01/200040). Autori se zahvaljuju osoblju odeljenja Osnovno seme i Laboratoriji za ispitivanje semena Instituta za kukuruz Zemun Polje za izvođenje hemijskih tretmana i laboratorijskih analiza.

EFFECT OF CHEMICAL TREATMENT ON MOISTURE CONTENT OF PACKAGED SEEDS

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Chemical treatments applied on seeds as aqueous solutions is a common practice in seed processing aiming to protect seeds from pathogens during initial stages of germination. However, the application of aqueous solutions on the seed surface can cause increase in the moisture content inside of seeds what can increase a risk of declining germination due to accelerated aging during storage, as well as abundant development of pathogens and saprophytes. During routine laboratory testing of moisture content, it was noticed that in some samplesvalueswere approaching prescribed limits. This initiated research aiming to provide information if moisture, administered on seeds during chemical treatment, remains on the seed surface and then evaporates into the surrounding space or is absorbed by the seed thereby increasing the internal moisture content. Samples of cereal seeds for moisture determination were taken before the treatment, immediately after the treatment and from packaged seeds after a certain storage time. Moisture content was determined by the gravimetric method, prescribed by ISTA. Obtained results showed that the chemical treatment increases moisture content in seeds which, in most samples, remains stable during storage. Although this increase was not statistically significant, it suggests that the moisture content prior to treatments should be taken into account and that formulations should be adjusted by reducing the portion of water to the level which will not compromise distribution of chemicals on the seed surface.

Key words: seed, moisture, treatment, seed ageing

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V-POS-17

U KOJOJ MERI ZAKASNELA ŽETVA UTIČE NA KVALITET SEMENA SOJE?

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Žetva soje se obavlja pri nastupanju tehnološke zrelosti, a vlažnost u zrnu dostigne oko 13%. Različiti faktori mogu uticati da se žetva ne obavi u optimalnom roku, te se u praksi događa da se žetva obavlja i pri nižoj vlažnosti zrna od optimalne. U slučaju žetve sa nižom vlažnosti u zrnu (ispod 11%) dolazi do oštećenja semena, a ono je lošijeg kvaliteta. U kojoj meri zakasnela žetva utiče na prinos i kvalitet soje prikazan je u jednogodišnjem ogledu. Ogled je postavljen na lokalitetu Rimski šančevi sa tri sorte soje (NS Atlas (0 GZ), NS Apolo (I GZ) i Rubin (II GZ)), u tri ponavljanja. Žetva je obavljena kada je postignuto 13% vlažnosti zrna, a nakon toga je žetva pomerana za sedam, pa za četrnaest dana. Vlažnost semena nakon sedmog dana od optimalne vlažnosti je bila u rasponu od 8,5 do 10%, a nakon četrnaestog dana je bila ispod 8,5%. Prinos za sve tri navedene sorte se kretao od 4,1 do 4,6 t/ha, nakon sedmog dana od 4 do 4,4 t/ha, a nakon četrnaestog dana od 3,9 do 4,3 t/ha. Klijavost i energija u optimalnom terminu žetve su iznosile od 98 do 100%, nakon sedam dana od 81 do 86%, a odlaganje žetve za četrnaest dana je smanjilo klijavost na 72 do 82%. Zakasnela žetva direktno utiče na smanjenje kvaliteta semena soje, kao i na prinos, te je žetva u optimalnom roku jedan od odlučujućih faktora za dobijanje semena soje visokog kvaliteta.

Ključne reči: soja, vlažnost, žetva

Zahvalnica: Rad je podržalo Ministarstvo nauke, tehnološkog razvoja i inovacija Republike Srbije, ugovor broj 451-03-68/2022-14/ 200032), Centar izuzetnih vrednosti za leguminonoze (CIVL).

IS THE QUALITY OF SOYBEAN SEED AFFECTED BY DELAY IN HARVEST?

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Soybean is ready for harvesting when plants reach full maturity and the grain moisture is 13%. Various factors can influence harvest delay, and that the harvest is done at a lower than optimal grain moisture. Harvesting with lower moisture content (below 11%), cause seed damages and the seed has significantly poorer quality. The extent to which a delayed harvest affects the yield and quality was shown in a one-year experiment. The trial was set up at the Rimski šančevi site with three soybean varieties (NS Atlas (0 MG), NS Apolo (I MG) and Rubin (II MG)) in three replications. Harvest start at optimal seed moisture (13%) and after that, harvest was delayed for 7 and 14 days. After the seventh day the moisture was in the range of 8.5 to 10%, and after the fourteenth day was up to 8.5%. The yield for all varieties was in the range from 4.1 to 4.6 t/ha, after seventh days from 4 to 4.4 t/ha and after the fourteenth days from 3.9 to 4.3 t/ha. Germination and energy at the optimal harvest time ranged from 98 to 100%, after seventh day from 82 to 86% and delayed harvest after fourteenth days reduced germination from 72 to 82%. Delayed harvest directly affects soybean seed quality and yield, therefore, harvesting in the optimal period is one of the key factors for attain high quality soybean seed.

Key words: soybean, moisture, harvest

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V-POS-18

ZP 5557 – NOVI HIBRID KUKURUZA

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Hibridi srednje grupe zrenja FAO 500 imaju sve veći značaj u proizvodnji kukuruza u Srbiji. Imajući u vidu da je u poslednjih nekoliko godina prisutan trend gajenja hibrida koji imaju niži sadržaj vlage u momentu žetve, hibridi grupe zrenja FAO 500 predstavljaju odličnu kombinaciju visokog prinosa i nižeg sadržaja vlage u zrnu. Mogu se ubirati i u klipu i u zrnu, što ih čini veoma dobrom alternativom za hibride kasnih grupa zrenja koji se odlikuju visokim potencijalom za prinos ali i visokim sadržajem vlage u žetvi. Hibrid ZP 5557 registrovan je 2023. godine. U ogledima Sortne komisije je ispitivan u periodu 2021-2022. godine. Karakteristično je da su obe godine bile nepovoljne za gajenje kukuruza, što se naročito odnosi na 2022. godinu. Hibrid ZP 5557 je u obe godine ispitivanja ostvario viši prosečan prinos u odnosu na prosek standardnih hibrida, uz niži sadržaj vlage i manji procenat poleglih i slomljenih biljaka. U dvogodišnjem proseku ostvario je prinos od 104,4% u odnosu na prosek standardnih hibrida. Na osnovu rezultata postignutih u ogledima sortne komisije, hibrid ZP 5557 biće uključen u postkomisijske oglede Instituta za kukuruz i u slučaju da ponovi dobar rezultat biće započeta komercijalizacija ovog hibrida.

Ključne reči: hibridi kukuruza, prinos zrna, sadržaj vlage

Zahvalnica: Rad je podržalo Ministarstvo nauke, tehnološkog razvoja i inovacija Republike Srbije, ugovor broj 451-03-9/2021-14/200040 i Evropska komisija kroz projekat TWINNING GREEN-EDITING VIBES FOR FΘΘD, broj 101059942.

ZP 5557 – NEW MAIZE HYBRID

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Hybrids of medium maturity group FAO 500 become more important in maize production in Serbia. Taking into account that in the last few years there has been a trend of growing hybrids with lower harvest moisture, the hybrids of the FAO 500 maturity group represent an excellent combination of high yield and lower grain moisture content in harvest. They can be harvested both in ear and grain, which makes them a very good alternative for hybrids of late maturity groups that are characterized by high yield potential but also high moisture content at harvest. Hybrid ZP 5557 was registered in 2023. It was tested in the trials of the State Variety Commission in the period 2021-2022 years. It is characteristic that both years were unfavorable for growing maize, which especially applies to the year 2022. Hybrid ZP 5557 achieved a higher average yield in both years of testing compared to the average of check hybrids, with lower moisture content and a lower percentage of broken and lodged plants. In the two-year average, it achieved a yield of 104.4% compared to the average of check hybrids. Based on the results achieved in the tests of the variety commission, hybrid ZP 5557 will be included in the post-official trials of the Maize Research Institute and in case it obtain good result, the commercialization of this hybrid will be started.

Key words: maize hybrids, grain yield, mositure content

Acknowledgments: Results obtained in the present study are a part of the Project 451-03-9/2021-14/200040 that was financed by the Ministry of Science and Technological Development of the Republic of Serbia and European Commission through the Project TWINNING GREEN-EDITING VIBES FOR FΘΘD, number 101059942.

V-POS-19

ZP 6090- NOVI HIBRID KUKURUZA INSTITUTA ZA KUKURUZ "ZEMUN POLJE"

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Već više od sedam decenija Institut za kukuruz "Zemun Polje" kontinuiranim radom na razvoju i stvaranju novih hibrida kukuruza prati korak sa savremenim trendovima u oplemenjivanju kukuruza. Oplemenjivači u Institutu za kukuruz "Zemun Polje" svojim radom na stvaranju novih hibrida kukuruza nastoje da odgovore na aktuelne potrebe tržišta ali i da primenom savremenih tehnologija (dihaploidi, molekularni markeri…) ubrzaju i povećaju preciznost i efikasnost svojih programa. Uvođenjem i ispitivanjem genetičkog materijala različitog porekla (ex-pvp materijal) u selekcionim programima se povećava diverzitet oplemenjivačkog materijala. Iako se, zbog klimatskih promena težište gajenja kukuruza u Srbiji pomera ka srednje ranim grupama zrenja, na tržištu postoji i dalje potreba za savremenim, prinosnim i stabilnim hibridima kasnijih grupa zrenja. Iz tog razloga Institut za kukuruz "Zemun Polje" posvećuje značajnu pažnju u svojim programima razvoju linija i hibrida kukuruza FAO 600-700 grupa zrenja. Kao rezultat tih programa je nastao i hibrid ZP 6090 koji je ispitivan u ogledima Sortne komisije Republike Srbije tokom 2021. i 2022. godine. Tokom obe godine ispitivanja na ukupno 13 lokacija, hibrid ZP 6090 se istakao odličnim performansama. Hibrid ZP 6090 je hibrid namenjen primeni savremenih tehnologija gajenja kukuruza. Ovaj hibrid ima modernu arhitekturu biljke koju karakteriše umerena visina, nizak položaj klipa i uspravan položaj listova. Na ovaj način omogućeno je gajenje u većim gustinama u odnosu na druge hibride iste grupe zrenja kao i primena intezivnog načina gajenja. Hibrid ZP 6090 pokazuje izraženu otpornost prema poleganju, a pokazuje i značajnu tolerantnost na sve ekonomski važnije bolesti i štetočine kukuruza. Zbog velike lisne površine, kvalitetnog zrna i izraženog stay-green svojstva pogodan je i za silažnu upotrebu.

Ključne reč: kukuruz, novi hibrid, prinos

Zahvalnica: Ovo istraživanje finansirano je od strane Ministarstva nauke, tehnološkog razvoja i inovacija Republike Srbije (broj ugovora: 451-03-47/2023-01/200040).

ZP 6090- NEW MAIZE HYBRID OF THE MAIZE INSTITUTE "ZEMUN POLJE"

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For more than seven decades, the "Zemun Polje" Maize Institute has been keeping up with modern trends in maize breeding through continuous work on the development and creation of new maize hybrids. The breeders at the "Zemun Polje" Institute strive to respond to the current needs of the market, but also to speed up and increase the precision and efficiency of their breeding programs by applying modern technologies (dihaploids, molecular markers...). By introducing and testing new genetic material of different origin (ex-pvp material) in breeding programs the diversity of breeding material is increased. Although, due to climate changes, maize cultivation in Serbia is shifting towards mid-early maturity groups, there is still a need on the market for modern, yielding and stable hybrids of later maturity groups. For this reason, the "Zemun Polje" Institute devotes considerable attention in its programs to the development of FAO 600-700 maturity groups maize hybrid. ZP 6090 is a new maize hybrid which was examined in trials of the Commission for the Variety Releasing of the Republic of Serbia in 2021 and 2022. During both years of testing at a total of 13 locations, ZP 6090 hybrid stood out with excellent performance. Hybrid ZP 6090 is a hybrid intended for modern maize cultivation technologies. This hybrid has a modern plant architecture characterized by moderate height, low ear position and erectophile leaf position. This allows ZP 6090 to be sown in higher densities compared to other hybrids of the same maturity group. Hybrid ZP 6090 shows pronounced resistance to lodging, and it also shows significant tolerance to all economically important maize diseases and pests. Due to the large leaf area, grain quality and stay-green properties, ZP 6090 is also suitable for silage use.

Key words: maize, new hybrid, yield

Acknowledgement: This study was supported by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia (Grant No. 451-03-47/2023-01/200040).

V-POS-20

NS 4006 – OD TEST UKRŠTANJA DO STANDARDA U SORTNOJ KOMISIJI

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U toku procesa identifikacije perspektivne hibridne kombinacije, priznavanja hibrida u sortnoj komisiji i odabira najboljih priznatih hibrida za semesku proizvodnju, jedna hibridna kombinacija prođe veći broj ogleda na različitim lokacijama i u različitim godinama gajenja. U ovom radu pokušali smo da prikažemo proces testiranja, kroz ostvarene rezultate hibrida kukuruza NS 4006. U pretkomisijskim ogledima 2017. godine NS 4006 je na 9 lokacija ostvario 106,3% prinosa zrna od proseka standarda, sa procentom pobeda 67% u odnosu na bolji standard. U komisijskim ogledima u 2018. i 2019. godini na ukupno 15 lokacija hibrid je postigao 104,6% prinosa zrna u odnosu na prosek standarda, uz procenat pobeda od 73% u odnosu na bolji standard. Na osnovu rezultata ovih ogleda, kao i na osnovu rezultata postkomisijskih mikro i proizvodnih ogleda, hibrid NS 4006 odabran je za komercijalnu semensku proizvodnju. Hibrid je registrovan i u Evropskoj Uniji 2021. godine. Takođe, od 2023. godine NS 4006 je standard za FAO 400 grupu zrenja u Ogledima za priznavanje sorti kukuruza Republike Srbije.

Ključne reči: hibridna kombinacija, prinos zrna, multilokacijski ogledi, *Zea mays L.*

NS 4006 – FROM A TEST CROSS TO A CHECK IN REGISTRATION TRIALS

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During the process of identifying a promising hybrid combination, variety registration and and selection the best registed hybrids for seed production, one hybrid combination undergoes a number of trials at different locations and in different growing years. In this paper, we tried to show the testing process, through the achieved results of the maize hybrid NS 4006. In preregistration trials in 2017, NS 4006 achieved 106.3% grain yield from average of two standards, with a winning percentage of 67% compared to the better standard. In registration trials in 2018 and 2019 at a total of 15 locations, the hybrid achieved 104.6% grain yield compared to average of two standards, with a winning percentage of 73% compared to the better standard. Based on the results of these trials, as well as on the results of postregistration micro-trials and strip trials, the hybrid NS 4006 was selected for commercial use in the seed production. The hybrid was registered in the European Union in 2021. Also NS 4006 was introduced as standard for the FAO 400 group in maize variety registration trials in Republic Serbia.

Key words: grain yield, hybrid combination, multilocation trials, *Zea mays* L.

V-POS-21

MORAVSKA LEPOTICA – NOVA SORTA PAPRIKE INSTITUTA ZA POVRTARSTVO SMEDEREVSKA PALANKA

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Paprika (*Capsicum annuum L.*) je jedna od najvažnijih povrtarskih vrsta kako zbog površina na kojima se gaji, tako i zbog raznovrsne upotrebe od svežeg stanja do različitih proizvoda u industrijskoj preradi. Zbog sve veće potražnje kvalitetnih plodova paprike za industrijsku preradu postavili smo sebi za cilj stvaranje nove sorte paprike sa visokim prinosom i sadržajem suve materije. Nakon višegodišnjeg procesa selekcije, *pedigree* metodom selekcije stvorena je Moravska lepotica, sa visokim sadržajem suve materije i boje, veoma krupnih i atraktivnih plodova. Ona je priznata Rešenjem Ministarstva poljoprivrede, šumarstva i vodoprivrede Republike Srbije pod br. 320-04-3330/2/2021-11 od 22.12.2022.

Ključne reči: paprika, Moravska lepotica, selekcija, pedigre metod, suva materija

MORAVSKA LEPOTICA – NEW PEPPER VARIETY AT THE INSTITUTE FOR VEGETABLES CROPS, SMEDEREVSKA PALANKA

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Pepper (*Capsicum annuum* L.) is one of the most important vegetable varieties both, due to large area on which it is cultivated all over the world and due to its various food processing industry usage both fresh and proceeded. Due to the increasing demand for high-quality pepper fruits for industrial processing, our goal was to create a new pepper variety with a high yield and dry matter content. After many years of selection, new variety named "Moravska lepotica" (The Moravian beauty) was created by applying the pedigree method. This variety had high content of dry matter and colour, very large and attractive fruits. It was recognized by the Ministry of agriculture, forestry and water management of the Republic of Serbia, No 320-04-3330/2/2021-11 dated 22.12.2022.

Key words: pepper, Moravska lepotica, selection, pedigree method, dry matter

V-POS-22

JASMINKA – NOVA SORTA SOJE INSTITUTA ZA KUKURUZ „ZEMUN POLJE“

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Oplemenjivački rad na soji u Institutu za kukuruz „Zemun Polje“ za cilj ima stvaranje sorti standardnog kvaliteta zrna visokog i stabilnog prinosa, tolerantnih na abiotičke i biotičke faktore spoljašnje sredine, te otpornih prema poleganju i pucanju mahuna. Kao rezultat ovog procesa, u toku 2023. godine priznata je sorta soje "Jasminka". Kao početni materijal za dobijanje varijabilnosti segregirajuće populacije korišćeni su domaći genotipovi soje, a primenjen je *pedigree* metod selekcije. Sorta pripada grupi zrenja I, sa dužinom vegetacije od oko 125 dana, zavisno od temperaturne sume i obezbeđenosti vlagom u toku vegetacione sezone. Preporučeno vreme setve je polovina aprila, a optimalna gustina useva 450000 biljaka/ha. U sortnim ogledima Odseka za priznavanje sorti, Uprave za zaštitu bilja Ministarstva poljoprivrede, šumarstva i vodoprivrede Republike Srbije izvedenim u toku 2021. i 2022. godine na četiri lokaliteta, ostvarila je prosečan prinos od 2,71 t/ha. S obzirom da su obe godine ispitivanja bile nepovoljne za gajenje soje (suša u 2022.), sorta je ispoljila i dobru toleranciju na deficit vlage. Masa 1000 zrna iznosi oko 200 g. Sadržaj proteina u zrnu je visok i iznosi 43,3%, dok je sadržaj ulja na zadovoljavajućem nivou (19,7%). Sorta se odlikuje srednje visokim stablom (90-110 cm) indeterminantnog tipa porasta, uspravnim habitusom, sivim maljama i ljubičastim cvetom. Mahuna je svetlo braon boje, a seme je žute semenjače i svetlo braon hiluma. Sorta se odlikuje dobrom otpornošću na poleganje, te je pogodna za gajenje u uslovima navodnjavanja.

Ključne reči: soja, oplemenjivanje, prinos

Zahvalnica: Ovo istraživanje finansirano je od strane Ministarstva nauke, tehnološkog razvoja i inovacija Republike Srbije (broj ugovora: 451-03-47/2023-01/200040).

JASMINKA – A NEW SOYBEAN VARIETY DEVELOPED AT MAIZE RESEARCH INSTITUTE ZEMUN POLJE

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Soybean breeding program at the Maize Research Institute Zemun Polje aims to create varieties of standard grain type, with high and stable yield and good tolerance to abiotic and biotic factors of the environment, resistant to lodging and shattering, with special emphasis on short and mid-season varieties. As a result of this program, a new soybean variety "Jasminka" was released in year 2023. Domestic, well adapted soybean genotypes were used as parental material for developing the variability of the segregating population, and the *pedigree* method of selection was applied. The variety belongs to maturity group I, with 125 days to maturity, depending on the sum of active temperatures and water supply during the season. The recommended sowing time is mid-April, and the optimal crop density is 450000 plants/ha. In variety trials of the Department for Recognition of Varieties, Directorate for Plant Protection of the Ministry of Agriculture, Forestry and Water Management of the Republic of Serbia conducted in 2021 and 2022 at four locations," Jasminka" achieved an average yield of 2.71 t/ha. Despite the fact that both years of testing were unfavourable for soybean production (drought in 2022), the variety showed good tolerance to soil moisture deficit. A 1000-seed weight is around 200 g. The protein content in the grain is high and amounts to 43.3%, while the oil content is at a satisfactory level (19.7%). A new variety has medium-high stem (90-110 cm), indeterminate type of growth, erect habit, gray pubescence and a purple flower. Pods are a light brown, and the seed coat is yellow with a yellow hilum. The variety has good resistance to shattering and lodging, and is suitable for growing in irrigation system.

Key words: soybean, breeding, seed yield

Acknowledgment: This study was supported by the Ministry of Science, Technological Development and Innovation of the Republic of Serbia (Grant No. 451-03-47/2023-01/200040)

V-POS-23

ŠEMA SEMENSKE PROIZVODNJE HIBRIDA KUKURUZA U BUGARSKOJ

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Institut za kukuruz iz Kneže je jedan od glavnih centara za selekciju i proizvodnju semena kukuruza u Bugarskoj. U svojoj skoro 100-godišnjoj istoriji Institut ima 130 registrovanih hibrida u različitim grupama zrenja, razvijenih za različite namene: hibride za zrno, za stočnu hranu, hibride specifičnog kvaliteta, hibride otporne na abiotički stres, bolesti i štetočine. Poslednjih godina posebna pažnja se poklanja hibridima sa povećanim sadržajem skroba koji su pogodni za proizvodnju bioetanola, kao alternativnog goriva iz obnovljivih izvora. Proizvodnja hibridnog semena pretežno se zasniva na primeni citoplazmatske muške sterilnosti (CMS), što ga čini jeftinijim i konkurentnijim na tržištu semena. Da bi se dobilo hibridno seme primenjuju se tri glavne metode: 1) na fertilnoj osnovi – metoda zahteva 100% uklanjanje metlica majčinske komponente. Ovaj metod se primenjuje kada nedostaje majčinska sterilna varijanta; 2) mešoviti metod (sa 30% ručnog zakidanja metlica). Primenjuje se u onda kada postoji muško sterilni analog kao i održavaoc sterilnosti majčinske komponente, kao i komponenta oca, koja nema sposobnost vraćanja fertilnosti. Da bi budući hibrid imao dovoljan broj fertilnih biljaka, 1/3 redova majke treba zasejati fertilnim analogom i zakinuti metlice. Tokom berbe, svi redovi majke beru se zajedno. Nakon žetve i dorade dobija se homogena mešavina hibridnog semena na fertilnoj i sterilnoj osnovi. 3) metoda koja se zasniva na sterilnoj osnovi uz povraćaj fertilnosti. Primenjuje se u prisustvu CMS analoga majke i oca koji je homozigotni restorer fertilnosti. Proizvodnja hibridnog semena kukuruza zasnovana na CMS-u, praćena vraćanjem fertilnosti se pokazala se kao najjeftiniji i najkvalitetniji metod za dobijanje hibridnog semena.

Ključne reči: muška sterilnost, proizvodnja semena, *Zea mays* L.

SEED PRODUCTION SCHEMES IN MAIZE HYBRIDS IN BULGARIA

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Maize Research Institute, Knezha, is one of the main centers for maize selection and seed production in Bulgaria. In its almost 100 years history the Institute has 130 registered hybrids in different maturity groups, and for various purposes – for seed, forage, hybrids with special determined qualities, hybrids sustainable to abiotic stress, diseases and pests. In the last years special attention is being paid to hybrids with increased starch content that are suitable for bioethanol production, as an alternative fuel from renewable sources. Hybrid seed production is predominantly based on the application of cytoplasmic male sterility (CMS), which makes it cheaper and more competitive in the seed market. In order to obtain maize hybrid seeds, three main methods are applied: 1) on fertility base – where we have 100% detasselement of mother line. This method is applied when the mother sterile counterpart is missing; 2) mixed method - with 30% manual detasselement. It is applied in the presence of male sterile counterpart and sterility maintainer, and the father line is a non-restorer. In order for the hybrid to have sufficient number of flowering plants, 1/3 of the maternal line is being planted with fertile counterpart, and they should be detasseled. During the harvest, all mother rows should be harvested together. After the numerous treatments following the harvest, a homogenous mix of hybrid seeds on fertile and sterile base is obtained; 3) Sterility rebuilding method is applied in the presence of a sterile mother line and father is homozygote fertility restorer. CMS-based seed production followed by fertility rebuilding proved to be the most inexpensive and high-quality method to obtain hybrid seeds.

Key words: male sterility, seed production, *Zea mays* L.

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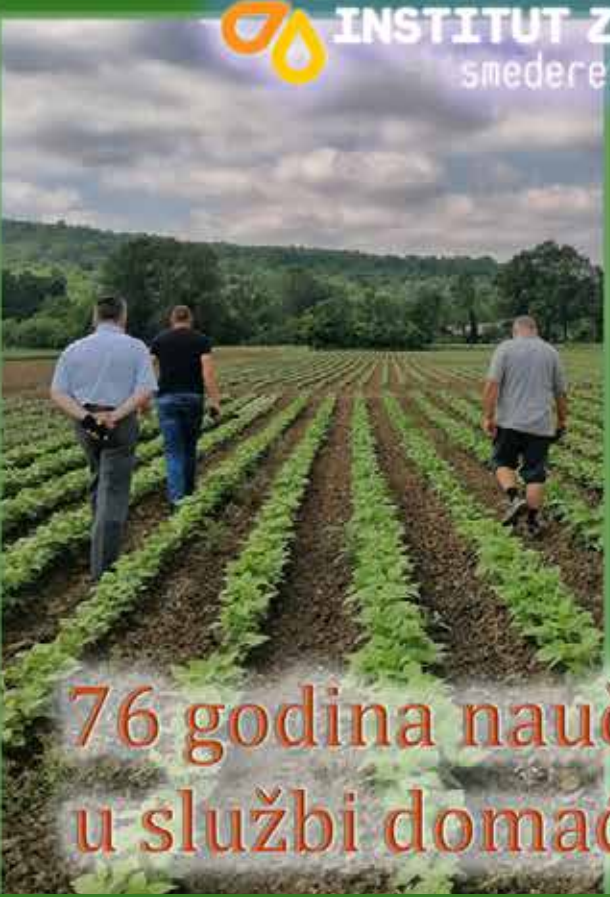

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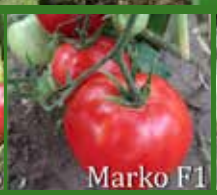
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Moravska lepotica